V930006

COMMISSION AUTHORIZED

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the matter of

Expanded Interconnection with Local Telephone Company Facilities	)	CC Docket No. 91-141 Transport Phases I & II
Amendment of Part 36 of the Commission's Rules and Establishment of a Joint Board	)	CC Docket No. 80-286

Comment of the Staff of the Bureau of Economics of the Federal Trade Commission*

March 5, 1993

---

* This comment represents the views of the staff of the Bureau of Economics of the Federal Trade Commission. They are not necessarily the views of the Commission or any individual Commissioner. Inquires regarding this comment should be directed to Richard Shin (202-326-3495) or Michael R. Ward (202-326-2096) of the FTC's Bureau of Economics.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the matter of

Expanded Interconnection with Local Telephone Company Facilities	)	CC Docket No. 91-141 Transport Phases I & II
Amendment of Part 36 of the Commission's Rules and Establishment of a Joint Board	)	CC Docket No. 80-286

Comment of the Staff of the Bureau of Economics of the Federal Trade Commission[1]

I. Introduction and Summary

The staff of the Bureau of Economics of the Federal Trade Commission (FTC) appreciates this opportunity to submit this comment in response to the Federal Communications Commission's (FCC) Second Notice of Proposed Rulemaking[2] ("Second Notice") concerning proposals to require certain local exchange carriers (LECs) to offer expanded opportunities to interconnect with their

---

[1] This comment represents the views of the staff of the Bureau of Economics of the Federal Trade Commission. They are not necessarily the views of the Commission or any individual Commissioner. Inquires regarding this comment should be directed to Richard Shin (202-326-3495) or Michael R. Ward (202-326-2096) of the FTC's Bureau of Economics.

[2] Second Notice of Proposed Rulemaking In the Matter of Expanded Interconnection with Local Telephone Company Facilities, CC Docket No. 91-141 Transport Phases I & II, (Released October 16, 1992).

switched access networks for the provision of interstate switched transport.[3] The FCC anticipates that the measures contemplated by the Second Notice will provide opportunities for efficient entry into the provision of switched access services and reduce switched access rates. The analysis contained in this comment supports these views, and we therefore support the Second Notice's proposals to introduce additional competition to the local transport element of the switched access market.

Two basic issues raised by the Second Notice are: whether to encourage competition for interstate local transport by requiring LECs to offer interconnection to non-LEC entrants and, if so, how much pricing flexibility to permit LECs in light of expected entry. Our analysis suggests that permitting non-LEC firms to provide local transport services, combined with requiring LECs to provide the local loop access to end users necessary to complete long distance calls, would benefit consumers. Our analysis also suggests that permitting LECs greater flexibility to price their services according to their costs will help insure that only efficient entry occurs.

This comment addresses four specific points pertinent to these two broad issues: (1) the conditions under which common carrier obligations, such as requiring LECs to provide expanded interconnection for switched access services, can be supported on economic efficiency grounds; (2) the magnitude of the difference

---

[3] This comment addresses issues relating to economic efficiency and competition. It does not take a position on other policy considerations that may be of relevance to the FCC.

between the cost of providing switched access and its price; (3) the degree to which special access is a substitute for switched access; and (4) the importance of providing the LECs some pricing flexibility at the same time they are required to provide expanded interconnection opportunities to third parties. We believe that the analysis and empirical findings contained in this comment are consistent with the FCC's tentative conclusion that switched access interconnection is likely to benefit consumers and competition.

Interstate switched access services can be separated into two components: local transport services (which connects the IXC POP with the LEC central office) and local loop access (which includes necessary switching services and connecting the LEC central office with end users.) Permitting entry into local transport services can be justified if the cost of providing both local transport and local access is no greater when two firms supply local transport than when one firm supplies both services. If entry into local transport is permitted, compelling LECs to provide expanded interconnection can be economically justified if it can be established that local telephone service is provided by a regulated natural monopoly that, absent such a requirement, would have an incentive to deny local loop access to some entrants in local transport service that wish to purchase it. Recent empirical results support these two conditions. It is likely, therefore, that requiring LECs to provide such access would benefit consumers and promote economic efficiency.

Existing studies of LEC costs strongly suggest that switched access prices currently are well above their marginal costs. This comment provides estimates suggesting that the prices charged by LECs for switched access services are several times their marginal costs. The estimates also indicate that these differences are used to subsidize local residential service, whose prices are well below their marginal costs.

At the same time it issued this Second Notice, the FCC released an order ("Special Access Order") containing important new regulations concerning LEC-supplied special access.[4] The regulatory changes described in the Special Access Order will increase the number of sellers offering special access services and reduce the prices of these services. While it is generally recognized that these changes will induce some end users currently using switched access to opt for special access, no empirical estimates of this demand substitutability have previously been available. In this comment, we report recent estimates of the degree of substitutability between switched and special access. These estimates suggest that a significant amount of long distance traffic would migrate to special access from switched access if the proposed regulations covering switched access are not adopted.

If restrictions on entry into local transport services are relaxed, as contemplated by this Second Notice, the difference between the LEC's marginal cost of switched access service and its

---

[4] Expanded Interconnection with Local Telephone Company Facilities, Report and Order, CC Docket No. 91-141, FCC 92-4409 (Release October 16, 1992) ("Special Access Order").

price will invite entry, possibly by firms with costs higher than those of the LEC. Under such circumstances, the Second Notice recognizes that the LECs must be permitted to respond to this entry with lower prices. The Special Access Order will permit LECs to establish "density pricing zones" under which special access prices can better reflect costs.[5] The Second Notice proposes to carry this further, allowing LECs under price-cap regulation some degree of flexibility in pricing switched access services within these zones.[6] While we do not address in detail how to structure such flexibility, we strongly support the Second Notice's proposal to provide greater pricing flexibility to the LECs, because such flexibility is central to ensuring that entry will occur due to a cost advantage of the entrant, and not a regulated price umbrella for the incumbent.

---

[5] In general, it is less costly to serve dense, urban areas than rural areas. Prior to the adoption of the Special Access Order, LEC prices reflected the average cost of providing service to end users located throughout its service area, both urban and rural. By establishing density pricing zones, LEC prices can better reflect the lower costs of serving urban areas.

[6] Second Notice, para. 32-34.

II. Expertise of the Staff of the Federal Trade Commission

The FTC is an independent regulatory agency responsible for maintaining competition and safeguarding the interests of consumers.[7] The staff of the FTC, upon request, often analyzes regulatory or legislative proposals that may affect competition or the efficiency of the economy. In the course of this work, as well as in antitrust and consumer protection research and litigation, the staff apply established principles and recent developments in economic theory to competition and consumer protection issues, including efficiency rationales for rate and entry regulation.[8] In addition, the staff of the Bureau of Economics of the FTC has studied the effects of price and entry regulations on long distance telephone service.[9]

---

[7] 15 U.S.C. §§ 41 et seq.

[8] For example, the staff of the FTC submitted comments to the Postal Rate Commission concerning recent advances in the economic theory of regulated monopolies. See Comments of the Staff of the Bureau of Economics of the Federal Trade Commission, Before the United States of America Postal Rate Commission, Monopoly Theory Inquiry, Docket No. RM89-4 (September 1, 1989). See also Comments of the Staff of the Bureau of Economics and the Chicago Regional Office of the Federal Trade Commission, Before the Illinois Commerce Commission, In the Matter of The Blue Ribbon Telecommunications Task Force Outline of Purpose and Request for Assistance (October 19, 1990).

[9] See Alan D. Mathios and Robert P. Rogers, The Impact of State Price and Entry Regulation on Intra-State Long Distance Telephone Rates, FTC Bureau of Economics Staff Report (November 1988).

III. Background

This proceeding is one of several dealing with the services provided by local exchange carriers (LECs) to long distance carriers (interexchange carriers or "IXCs"). Before discussing the details of these proceedings, we provide a brief description of the relationship between LECs and IXCs.

LECs provide local telephone services; IXCs provide long distance services. To provide long distance service, IXCs require "access" to end users (e.g., households, businesses). These end users are already connected to the LEC, so IXCs typically obtain access to them by connecting with the LEC and purchasing end-user access from it.

LECs offer two types of end-user access to IXCs: switched access and special access. Switched access can be broken down into three components: connecting end users to the nearest LEC central office; switching services performed at the LEC central office (to route calls to the proper IXC); and transporting calls between LEC central offices and the nearest IXC point-of-presence (POP). Switched access services represent a significant component of the price of a long distance telephone call.[10]

End users with greater demand for long distance services, typically large businesses, can avoid much of the expense of

---

[10] In 1990, long distance companies collected $52.1 billion in revenues for toll service and paid a total of $19.8 billion for end-user access. (This includes switched and special access for interstate and intrastate toll service). Total access payments represent approximately 38% of toll revenues. (U.S. Federal Communications Commission, 1990/1991).

switched access by connecting directly with the IXC POP. One way to do this is to purchase special access services from the LEC, which for sufficiently high calling volumes are priced lower than switched access service. Special access service involves ordering a dedicated line from the end user's premises to the LEC central office, and then having the LEC transport the calls from its central office to the IXC POP.[11] In contrast to the minute-of-use price for switched access, special access is priced as a monthly rental that depends on the capacity of the line and not actual usage. In terms of revenues collected, switched access is considerably larger than special access. In 1990, LEC charges for interstate switched access and interstate special access totalled approximately $11.0 billion and $2.6 billion respectively.[12]

It is also possible for IXCs to obtain access to end users by bypassing the LEC entirely. Recently, a number of firms, called Competitive Access Providers (or "CAPs"), have constructed localized fiber optic networks, usually in urban business districts. CAPs connect their localized network directly with the IXCs' POPs and with long-distance intensive end users, supplying an alternative to LEC-provided access.[13] The emergence of CAPs was

---

[11] The same line can transport both special access calls and switched access calls from the LEC central office to the IXC POP. See Second Notice, footnote 4.

[12] LECs charged an additional $6.2 billion for intrastate switched and special access.

[13] NYNEX estimates that CAPs supply 40% of the high-capacity market in New York City.

instrumental in the FCC's decision in 1991[14] to reconsider its regulations concerning access, both special and switched.[15]

The FCC regulates the prices charged by LECs to IXCs for switched and special access services.[16] While the pricing structures are complex, it is generally the case that switched access prices are based on minutes-of-use while special access prices are based on the capacity of the dedicated line (rather than actual use). Over the past few years, switched access prices have fallen considerably as the FCC permitted the LECs to lower the charges imposed on the IXCs while at the same time permitting them to introduce a fixed monthly fee (called the subscriber line charge) on end users.[17] Special access prices also have declined considerably partly because the FCC has permitted LECs to offer substantial volume discounts in markets where CAPs emerged.[18] Even with these price reductions, however, the prices for LEC-

---

[14] Special Access Order, para. 4-6. Larson and Mudd (1992) also provide a history and analysis of this issue.

[15] A number of states had also responded to demands from the LECs and from the CAPs to amend the regulatory structures pertaining to intrastate long distance traffic. Chief among these states are New York, Illinois, and Massachusetts. Special Access Order, para. 10.

[16] States regulate LEC prices for access services provided for intrastate long distance traffic. Because the same physical assets carry both interstate and intrastate long distance calls, some of the LECs assets are allocated between the interstate and intrastate jurisdictions in a necessarily arbitrary way. Regulated prices depend, to a large extent, on these cost allocations.

[17] In essence, the subscriber line charge simply increased local telephone rates relative to long distance rates.

[18] Special Access Order, para. 173.

supplied access are still well above their marginal costs. Given their relative prices, it would appear that the gap between price and marginal cost is larger for switched access than for special access. The differences in the deviations between prices and marginal costs provide end users incentives to substitute special access for switched access, and to substitute CAP services (whose prices are unregulated) for them both.

The FCC's Special Access Order

As a result of the Special Access Order, LECs, for the first time, will be required to permit third parties -- such as end users, IXCs, and CAPs -- to terminate their own transmission facilities at LEC central offices. The ability to interconnect directly with the LEC network for special access services will greatly facilitate development of substitutes for them. For instance, a CAP (or an IXC) will be permitted to install lines connecting LEC central offices and IXC POPs. End users could then buy special access services from the LEC to transport the call from their premises to the LEC central office, and then use the CAP (or IXC) to transport the call to the IXC POP. The FCC believes that "this growing competition will expand service choices for telecommunications users, heighten incentives for efficiency, speed technological innovation, and increase pressure for cost-based prices."[19]

---

[19] Special Access Order, para. 2.

Much of the Special Access Order specifies how the LECs must accommodate the demands from third parties wishing to interconnect with the LEC network at its central office. These complex "architectural" issues have been considered in the Special Access Order; we do not address them further in this comment. Of import for this proceeding is that the FCC believes that the architectural decisions described in the Special Access Order "laid the essential groundwork for expanded interconnection for switched transport."[20]

The Special Access Order also contains regulations specifying how LECs can price their new access services provided to third parties, and how LECs can modify the prices they charge for services they offer in competition with new suppliers. All-in-all, these special access pricing regulations are intended to move the prices charged by LECs for special access services closer to cost, and to permit LECs to alter more easily their prices in response to increased special access competition.

The Switched Access Second Notice

In the Switched Access Second Notice, the FCC tentatively concludes that the benefits likely to flow from expanded interconnection in the special access market would also flow from requiring expanded interconnection obligations for switched access services.[21] The FCC requests comment on this "tentative

---

[20] Special Access Order, para. 3.

[21] "We believe that benefits will arise from expanded interconnection for switched transport. The introduction of (continued...)

conclusion, addressing the potential benefits of switched transport expanded interconnection and possible drawbacks."[22] This comment addresses several issues pertinent to this proceeding: (1) the conditions under which expanded interconnection requirements can be supported on economic efficiency grounds; (2) the magnitude of the difference between the marginal cost of providing switched access and its price; (3) the degree to which special access has been a substitute for switched access; and (4) the importance of providing the LECs some pricing flexibility if they are required to provide expanded interconnection opportunities to third parties.

---

[21](...continued)
expanded interconnection for interstate switched transport would produce substantial benefits in addition to those to be realized from interstate special access expanded interconnection. . . Expanded competition and its associated pricing changes would provide a stimulus on the switched services side for increased efficiency in LEC operations, improved service provision, and greater access to diverse facilities that could improve network reliability." Second Notice, para. 10.

[22] Second Notice, para. 14.

IV. LECs Should Be Required to Offer Expanded Interconnection

The FCC's proposed rule would require larger LECs[23] to interconnect third parties with the LEC's switched access networks in order to foster competition for local switched transport. For purposes of analyzing this proposal, we believe it is useful to separate switched access into its three components: the connection between the IXC POP and the LEC central office (local transport), the switching services performed at the LEC central office, and the connections between the LEC central office and end users. For expositional purposes, we will combine the latter two components into one, called "local loop access".[24]

Currently, for switched access, LECs are the sole providers of local transport and local loop access. The proposed rule would require LECs first to unbundle these two services, and second to provide local loop access to all parties wishing to purchase it, even if local transport is purchased from other parties or provided by the IXCs. Such requirements would be economically justified if (1) permitting entry into local transport appears likely to be efficient and, if so, (2) requiring LECs to offer local loop access on a "common carrier" basis appears necessary. We believe that the evidence currently available suggests that both of these requirements are met.

---

[23] That is, LECs with more than $100 million in annual regulated revenues for a sustained period of time.

[24] To be precise, there is one more possible component included in local loop access: transporting the call between LEC central offices.

Restricting entry into local transport could be justified on economic efficiency grounds if the cost of providing both components of switched access (local transport and local loop access) is minimized when a single firm supplies them, and if, absent entry restrictions, a monopolist could not set prices that simultaneously allow it to break even and deter all entry.[25] Recently, however, the view that LECs, as currently configured, constitute a natural monopoly has been eroding. This is true even though the provision of certain LEC services, e.g. local loop access, are likely to exhibit substantial economies of scale and scope. We next discuss some of the recent economic research on LEC cost conditions. In general, this research supports the conclusion that permitting competition into local transport is likely to benefit consumers.

Recent empirical analysis suggests that the cost of providing both local loop access and local transport by one firm is not likely to be less than the cost of providing the services by two firms.[26] Shin (1988) estimated a LEC cost function at the central

---

[25] That is, if LECs are a nonsustainable natural monopoly, entry restrictions could be efficient. Sharkey (1982) provides a complete description of a natural monopoly, including the cost conditions that imply its existence and that determine whether the natural monopoly is sustainable.

[26] A number of studies examined whether the predivestiture Bell system was a natural monopoly. Results have been mixed largely because of data limitations. See Christensen, Cummings, and Schoech (1983), Evans and Heckman (1983), Charnes, Cooper, and Sueyoshi (1988), and Röller (1990). Shin and Ying (1992) cast doubt on natural monopoly cost conditions in local telephone service at the LEC level.

office level.[27] His estimated cost function included three broadly defined outputs: the number of end users with local loop access; the volume of local calls; and the volume of toll calls. As expected, simulations show that for a representative central office, there were economies of scope between local loop access and local calls, and between local loop access and toll calls. However, they also show diseconomies of scope between local calls and toll calls. This result suggests that entry into the services provided by central offices for toll calls (e.g., switching and local transport) could be efficient. Designing the appropriate policy is complicated, however, by the finding of economies of scope between local loop access and toll calls. Under the reasonable (but as yet empirically unexamined) assumption that the economies of scope between local loop access and toll calls stem from the switching services provided by the central office rather than its local transport services, permitting entry into local transport for toll calls would promote economic efficiency.

If entry is permitted into local transport services, new entrants will still need to purchase local loop access from the LEC to complete long distance calls. The proposed rule would require LECs to provide local loop access to all parties wishing to purchase it. Imposing such common carrier obligations, instead of permitting LECs to decide whether to interconnect particular third parties, appears sensible for two reasons. First, local loop

---

[27] In both Shin and Ying (1992) and Ying and Shin (1993) the unit of observation is the local exchange company and not the individual central office.

access at the central office level appears to be a natural monopoly. Second, LEC prices currently embody a significant subsidy from long distance services, including local transport, to local residential services. Thus, it seems unlikely that significant entry will arise to offer local loop access.

Shin (1988) found that, at the central office level, economies of scale and scope exist in the provision of local loop access, at least outside dense urban areas. Scale and scope economies exist because of excess capacity inherent in local loops (customer connection to the LEC's switch), common costs in obtaining rights-of-way, and large fixed costs to switching. First, doubling the number of calls for a given number of customers in a typical central office service area is likely to cause far less than a two-fold increase in costs because the local loop contains a significant degree of excess capacity. On average, only about 50 minutes a day are spent making telephone calls for each local loop. Thus, for the majority of end users, the average cost of a call falls with calling volume. Second, local loops to nearby end users are typically connected to the central office using common telephone poles or conduit. Thus, increasing the number of local loops in a typical central office service area also is likely to cause a less than proportionate increase in costs. Finally, a significant portion of the cost of switching is the software that manages the communications within the switch. Software costs are largely fixed and common to all calls, implying that average software costs fall with calling volume.

Still, economies of scale and scope at the central office level in the provision of local loop access need not justify a regulatory requirement compelling LECs to provide local loop access to any interested third party. This requirement appears justified, however, because LECs will likely have an incentive to discriminate against third party local transport providers. If the regulated prices of local loop access remain below the prices that maximize switched access profits, then the LEC can increase its profits by providing both local loop access and local transport services, if the latter continue to be priced above marginal cost. The LEC monopolist can maintain local transport prices above marginal cost by denying or limiting local loop access to some third parties.[28]

Even if common carrier obligations were imposed, these circumstances imply that LECs also would have an incentive to discriminate in the quality of the local loop access services provided to third parties. These quality concerns underlie, and justify, the detailed architectural requirements and interconnection standards contained in the Special Access Order that the FCC plans to extend to the switched access market.

---

[28] For a discussion of a regulated monopolist's incentives to tie regulated and unregulated services together, or to discriminate in the sales of its regulated services, see Brennan (1987). In the Special Access Order, the FCC imposed common carrier obligations on LECs for the provision of special access. See Special Access Order at para. 39. The justification for requiring LECs to provide interconnection for switched access is identical to that for requiring LECs to provide interconnection for special access. For a more detailed analysis supporting this requirement, see the U.S. Department of Justice's reply comments in the proceedings for the Special Access Order, pp. 17-20.

V. Implications of Interconnection for the Long Distance to Local Service Subsidy

Requiring LECs to provide local loop access to new entrants that provide local transport services will likely cause local transport prices to decline. Lower local transport prices would reduce the subsidy from long distance service to local telephone service, provided that the prices of the nonlocal transport portions of switched access services were not raised. Currently, the prices charged for local residential service are about half their marginal costs, while the prices charged for switched access are at least double their marginal costs. Switched access prices cannot be maintained above marginal cost in the presence of competition. To the extent that LEC interconnection introduces competition for switched access, the cross-subsidy will be diminished.[29]

Local residential telephone customers appear to be subsidized by users of other telephone services. Even including the full $3.50 per month residential subscriber line charge, local residential prices may be as low as one-half of their marginal costs. Local business telephone service, by contrast, is priced well above marginal cost, thereby providing a subsidy to residential service.[30] Interstate long distance service also

---

[29] See Faulhaber (1975).

[30] See Palmer (1992). She estimates the subsidy from business service to residential service is over $6 per line per month.

subsidizes local residential service because the IXCs typically pay for access an amount as much as twice its marginal cost.[31]

Studies have suggested that the maintenance of these cross-subsidies in the face of changing market conditions has imposed large social welfare costs, although we do not analyze this question directly.[32] Studies also have suggested that a recent reduction in cross-subsidies between long distance and local services benefited residential customers.[33] These studies address the efficiency aspects of reductions in the toll to local subsidy. We recognize that regulators may wish to consider public policy concerns other than economic efficiency when approving telephone prices for low-income residential callers. By addressing the

---

[31] Kahn and Shew (1987), pp. 196-197, provide evidence that the price of access was four or five times its marginal cost.

[32] See Rohlfs (1979), Griffen (1982), Wenders and Egan (1986), and Kasserman, Mayo and Flynn (1990) for evidence of the welfare costs due to inefficient pricing of long distance and local services. On the welfare costs of inefficient telephone service pricing: in general, see Mitchell (1978) and Wenders (1987); for directory assistance, see Daley and Mayor (1980); for local measured service, see Griffen and Mayor (1987); for business and residential service, see Palmer (1992).

[33] Imposition of the Subscriber Line Charge and concurrent reduction in switched access prices decreased the size of the cross-subsidy. Larson, Makarewicz and Monson (1989), who studied a large number of monthly bills for Southwestern Bell Telephone Company customers, report that the imposition of subscriber line charge significantly lowered the average subscriber's total telephone bill. They also report that calling patterns do not differ substantially between the average caller and low income callers (i.e., average annual household income less than $15,000 in 1988) and conclude that total telephone bills for average low income subscribers also fell. Crandall (1991), pp. 112-115, reports that local/long distance repricing caused reductions in telephone service costs of producing nontelephone goods and services, resulting in customers gaining between $2.64 and $11.82 per year in 1987.

relative prices of switched access and the possible local transport alternatives, the proposed rule has implications for the size of the long distance to local cross-subsidy.

Estimates of Marginal Cost and Contribution by Broad Category

Telephone service prices can be thought of as including the marginal cost of the service and a contribution to overhead costs. While first-best efficient prices equal marginal costs, such pricing may not cover costs if marginal costs are less than average costs. If the firm is to break even, prices must be set above marginal cost to recover the residual fixed and common costs. For second-best prices, the amount by which prices exceed marginal costs will depend on the size of the residual revenue requirement and, ideally, the demand elasticity of the service in question.[34]

We use the LEC cost function estimated by Ying and Shin (1993) to calculate the marginal costs for three LEC outputs: customer connections, local calls, and toll calls.[35] These three services represent a substantial degree of aggregation; data limitations prevent further disaggregation. Nevertheless, the estimates, properly interpreted, provide insight into the magnitude of the

---

[34] See Brown and Sibley (1986), pp. 39-44. In its simplest form, second-best pricing, or Ramsey pricing, yields the price-cost markup, $(P_i - MC_i)/P_i = \lambda / -\eta_i$ where P_i, MC_i and η_i are product i's price, marginal cost, and demand elasticity, respectively. λ (the "Ramsey number") increases with the size of the costs not recovered through marginal cost pricing. This formula becomes significantly more complex for a multiproduct firm.

[35] Shin and Ying (1992) and Ying and Shin (1993) are the only cost studies that provide marginal cost estimates at the LEC level.

cross-subsidy from toll service to local service. The estimated marginal costs are long-run marginal costs, i.e., they assume that LECs can minimize their total costs subject to their regulatory constraints in providing the demanded telephone services. For purposes of designing regulatory policy, we believe that long-run costs are appropriate.[36]

It is necessary to be precise as to what these three outputs represent. Customer connections include all local loops operated by the LEC. These represent an aggregation of business, residential, urban and rural connections which can have substantially different marginal costs. The estimated marginal cost of a customer connection represents a weighted average over all such classifications. Local and toll calls are the number of such calls handled by the LEC in the year. The total cost of local calling increases with capacity (e.g., more local interoffice trunks, larger switches) and not necessarily with usage. If capacity utilization is relatively constant across LECs and over time, then the number of local calls will be a fairly good proxy for capacity. The same points can be made for toll calls. Toll

---

[36] Other studies have estimated short-run marginal costs or incremental costs. The marginal-cost estimates based on Ying and Shin (1993) exceed those in other studies for three main reasons: (1) these other studies estimate short-run marginal or incremental costs; (2) they are done at the central office level; and (3) they use different output variables. Incremental cost studies, such as Mitchell (1990), assume that most of the costs (e.g., all nonrecurring costs) are fixed; Ying and Shin (1993), by contrast, allow these costs to vary in the long-run. The studies estimate that costs at the central-office level exclude firm-level costs that vary with outputs. We note that differences in output measures make direct comparisons among studies difficult.

calls here include intraLATA, interLATA intrastate, and interLATA interstate calls. The costs included are only those costs incurred by the LEC (e.g., switching and local transport for interLATA calls).

Table 1
Estimated Real Marginal Costs for
Customer Connections, Local Calls, and Toll Calls
1983 Dollars, 58 Observations per Year

Year	Customer Connections ($/Month)		Local Calls ($/Call)		Toll Calls ($/Call)	
	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
1976	25.07	(0.82)	0.036	(0.0028)	0.276	(0.0171)
1977	24.37	(0.78)	0.034	(0.0025)	0.253	(0.0150)
1978	25.05	(0.77)	0.032	(0.0024)	0.234	(0.0138)
1979	25.47	(0.76)	0.029	(0.0019)	0.206	(0.0097)
1980	26.78	(0.75)	0.026	(0.0018)	0.192	(0.0087)
1981	31.36	(0.88)	0.024	(0.0014)	0.179	(0.0081)
1982	33.79	(0.99)	0.026	(0.0012)	0.181	(0.0088)
1983	35.51	(1.30)	0.019	(0.0011)	0.173	(0.0083)
1984	42.96	(1.16)	0.028	(0.0016)	0.175	(0.0084)
1985	38.56	(0.92)	0.023	(0.0012)	0.156	(0.0065)
1986	34.37	(0.77)	0.021	(0.0012)	0.141	(0.0055)
1987	33.15	(0.81)	0.021	(0.0012)	0.124	(0.0053)

Estimates of LEC marginal costs are presented in Table 1. The average estimated marginal cost of a customer connection (in 1983 dollars) increased from 1976 through 1984 then declined. The

average for all years is $31.13 per month.[37] This estimate may understate the marginal cost of a residential connection because it includes some business lines that typically are shorter and entail a lower marginal cost per line. The estimated marginal cost of a customer connection should not be confused with the cost of only a local loop. To the extent that other services (e.g., directory assistance and billing) are used in proportion to the number of loops, but not the volume of local and toll calling, their costs are also included in the estimated marginal cost of a customer connection. Also, because additional loops typically require additional switching and trunking capacity in anticipation of calling volume, these costs are included in estimated marginal costs. Table 1 also shows that the average estimated marginal cost of a toll call fell from almost 28 cents to 12.4 cents during this period.[38] We interpret the marginal cost of a toll call as providing an approximation for the cost of switched access.[39]

---

[37] For over 90 percent of the sample points, the estimated marginal cost of a customer connection is between $20 and $48 per month.

[38] Again there are variations in the estimated marginal costs for toll calls. However, over 90 percent of all estimated marginal costs of a toll call were between $0.10 and $0.35. In 1987, all of the estimated marginal costs were between $0.075 and $0.22.

[39] This interpretation is subject to several qualifications. The data aggregate interstate and intrastate calls; only the former are regulated by the FCC. Further, the LEC provides different services for interLATA calls and for intraLATA calls. For interLATA calls (which can be either interstate or intrastate), the LEC provides switching and local transport for the ends of a call and does not provide the long distance transmission. For intraLATA calls (which are predominately intrastate) the LEC provides switching and trunking for the whole call. Notwithstanding these (continued...)

Table 2
Prices and Estimated Marginal Costs for
Local Residential Service and Switched Access
1983 Dollars

Year	Residential Local Service ($/Month)		Switched Access ($/Call)	
	Average Price	Marginal Cost	Average Price	Marginal Cost
1983	11.63	35.51		0.173
1984	12.85	42.96	0.833	0.175
1985	13.51	38.56	0.770	0.156
1986	14.72	34.37	0.671	0.141
1987	14.67	33.15	0.526	0.124
1988	14.01		0.445	
1989	14.14		0.372	
1990	13.61		0.293	
1991	13.66		0.261	

* Assuming that the average length of a toll call is five minutes.

Estimated marginal costs are compared with average prices[40] in Table 2. The price of local service is always less than half its marginal cost. While the price of switched access has fallen dramatically since 1987, it was four times its marginal cost prior to 1987. Even if the marginal cost of switched access did not

[39](...continued)
complications, it seems reasonable to interpret the estimated marginal cost for toll calls generated in this analysis (12.4 cents per call in 1987) as the marginal cost of providing carrier access.

[40] Price information is from U.S. Federal-State Board (1992), pp. 288, 294. Prices are deflated using the CPI. For comparison purposes, switched access prices per minute were converted to prices per call assuming an average call duration of five minutes.

continue its downward trend, it is likely still to be significantly below its price. This table provides evidence that the cross-subsidy from long distance to local service is still large.

It is often argued that pricing toll calls above marginal cost is necessary to cover the fixed costs of the local network. The preceding discussion shows, however, that much of the difference between the price and marginal cost of a toll call serves to subsidize customer connections. It is possible to estimate the "revenue shortfall" that would result if all outputs were priced at marginal cost. "Revenue shortfall" for a given mix of outputs is the difference between total costs and the revenues that would be collected if prices equaled marginal cost. If actual quantities are used, then estimated revenue shortfalls for 1976-1987 average only about 2 percent of total costs.[41] This percentage is fairly stable over time.[42] This indicates that efficient (e.g., Ramsey) prices would have contribution elements quite small relative to marginal cost. For switched access in particular, contribution elements would be much smaller than current prices imply.

---

[41] Since toll prices are substantially above their marginal costs, existing toll quantity will understate the quantity that would occur if price equals marginal cost. Since toll service is much more demand elastic than local service, adjusting for this effect will tend to decrease the revenue shortfall. Shin (1988) reports similarly defined revenue shortfalls of 15% for a cost function estimated at the central office level. However, this marginal cost at the central office level does not include costs incurred outside the central office due to actions taken by the central office. This could account for the larger revenue shortfall using marginal cost pricing.

[42] Before 1984, Bell shortfalls were larger, in percentage terms, than the nonBell shortfalls.

Cross-Subsidization and Bypass

Cross-subsidization of local residential service by long distance service encourages end users and IXCs to bypass the LECs because access prices are so far above their marginal cost. Bypass concerns were the initial justification for reducing Carrier Common Line Charges and implementing Subscriber Line Charges.[43] Yet, despite the large reductions in switched access prices, switched access avoidance has grown substantially.[44]

The Special Access Order, which provides CAPs and IXCs expanded interconnection opportunities for special access, seems likely to foster additional bypass of some LEC facilities. The magnitude of this bypass depends in large measure on the extent to which special access and switched access are substitutes in demand. While many commenters have noted this, none have presented estimates of the degree of substitutability. Parsons and Ward (1993) estimate that the elasticity of substitution in demand[45] between switched and special access is -0.34 for AT&T and -0.21 for the Other Common Carriers (OCCs).[46] Tnese estimates imply that a

---

[43] See Bell Communications Research (1984), Brock (1984), Jackson and Rohlfs (1985) and USTA (1984).

[44] See Brittman, et al. (1989), Grandstaff and Watters (1989), U.S. Federal-State Joint Board (1992), pp. 299-306.

[45] The elasticity of substitution in demand is not to be confused with the more familiar cross elasticity in demand. The elasticity of substitution in demand measures the percentage change in the ratio of the quantity demanded of two goods due to a percentage change in the ratio of their prices.

[46] While the AT&T estimate is highly statistically significant, the OCC estimate is not. It is possible that the OCC (continued...)

price increase in switched access relative to special access of 10%[47] would induce a 3.4% decrease in the proportion of switched to special access demanded by AT&T and a 2.1% decrease for the OCCs. Because the price markup over marginal costs is larger for switched access than for special access, such changes could reduce significantly the income that the LECs derive from sales to the IXCs (the IXC "contribution") if switched access prices are not reduced. These estimates suggests that delay in implementing the proposals concerning interconnection for switched access will lead to a significant reduction in the demand for switched access services.

Parsons and Ward (1993) also show that when regulators require that a LEC service with imperfect substitutes generate a fixed dollar level of revenue recovery, because it has been allocated a fixed amount of the common costs, end users with a greater demand for the service have an incentive to remain with the LEC. In this context, LECs typically have fixed dollar revenue requirements for switched access. Larger IXCs (such as AT&T) have an additional incentive to use LEC switched access because shifting some of its purchases to special access or CAP bypass causes switched access

---

[46](...continued)
estimate is lower because, in some instances, special access is used as a complement with switched access. To reduce switched access local transport costs, some OCCs have installed "closet POPs" in areas remote to their existing POPs and connected them with LEC-provided special access.

[47] This figure is illustrative only. It is unclear just how large the price decreases for special access will be as a result of the special access interconnection order The FCC clearly expects some price reductions (Special Access Order, para. 2).

prices to increase for the remaining purchases. If IXCs recognize that using alternative services causes switched access prices to rise, then they would include this price increase as a cost of using the substitute.

In principle, this phenomenon (called the "Brandon Effect") could diminish LEC concerns about the potential loss of revenues due to users bypassing the switched network. However, two current trends in telecommunications regulation could greatly attenuate the Brandon Effect. First, increasing numbers of LECs are being regulated via price-cap or incentive regulation. To the extent that such approaches do not arbitrarily assign fixed and common costs to different services for recovery, they render the fixed dollar revenue requirement obsolete. Instead, prices would tend toward the point where marginal revenue equals marginal cost and rely less on an arbitrary assignment of fixed costs. Second, expanded competition for carrier access could render the revenue target unattainable. The Brandon Effect mechanism requires that the LEC switched access demand elasticity be less than one (in absolute terms) so that price increases generate revenue increases. Increased competition between LECs, CAPs, IXCs and end-users could cause the LEC switched access demand elasticity to exceed one.[48]

In sum, the important new regulations contained in the Special Access Order will likely reduce, perhaps significantly, the demand for switched access services. In some cases, the migration from

---

[48] See Landes and Posner (1981) for the various factors influencing the demand elasticity of a particular firm's product.

switched access to its alternatives could occur even though the LEC's costs of supplying switched access are less than those of the new suppliers. Current regulations, however, inhibit LECs from reducing switched access prices. This suggests that the FCC should consider implementing its proposals concerning switched access services as expeditiously as possible.

VI. LECs Should Be Provided Pricing Flexibility

Competitive entry into previously monopolistic services provides powerful incentives for the creation of an efficiently operating market.[49] In the short run, the threat of losing a customer to a competitor induces the incumbent firm to maintain prices close to marginal cost. The incumbent loses its monopoly profits, but the increase in consumer welfare from lower prices more than offsets this loss. In the long run, competition provides incentives for the incumbent to become more productive. Firms that use inputs more efficiently and continue to develop more efficient production techniques can expect to be rewarded with greater profits.

However, for the introduction of competition into a regulated market to foster more efficient prices, the regulated incumbent must be allowed to set prices closer to marginal cost. Currently, local transport prices are required to be the same even when their marginal costs are substantially different. For instance, it is less costly to serve dense, urban areas than rural areas. Without the ability to set prices closer to the actual cost of service, LECs will provide a pricing umbrella in the low cost markets under which CAPs can enter at prices substantially above LEC costs. It is possible that, in some of these cases, the LEC would be the low cost provider but the price umbrella allows CAPs to enter nevertheless. Some LEC pricing flexibility would be required so

---

[49] An exception is the case of an nonsustainable natural monopoly, where prices and entry are regulated as discussed in section IV above.

that LECs could respond to potential CAP entry and, thus, induce only efficient entry.[50]

Should less efficient entrants operate under a regulated price umbrella, the regulatory response consistent with economic efficiency would eliminate the price umbrella, not maintain or reinstate entry barriers. Moreover, even if the price umbrella is not eliminated, the social cost of inefficient entry must be weighed against the social cost of the price distortion. An inefficient entrant will produce its product at a cost greater than the possible minimum and this represents a social cost. However, it will also offer its product at a price below the LEC's and this represents a social gain. Depending on the actual market and cost conditions, entry by a firm less efficient than the incumbent into a market with a regulated price umbrella could be welfare increasing.

In its interconnection order for special access, the FCC recognized that LEC pricing flexibility was necessary to promote efficient entry.[51] The same conditions are likely to hold for switched access local transport indicating that some degree of pricing flexibility is appropriate.

---

[50] Palmer (1992) addresses the issue of efficient entry in local telephone service relating to cross-subsidies from low-cost high-priced local business service to high-cost low-priced local residential service. If entry were to occur, it would be isolated to business service where the divergence between prices and costs are large enough to induce (potentially) inefficient entry. She concludes that if prices better reflected costs, entry would occur only where the entrant had lower costs.

[51] Second Notice, para. 32.

VII. Conclusions

The FCC anticipates that the measures contemplated by the Second Notice will provide opportunities for efficient entry into switched access services and reduce their prices. The analysis in this comment supports these views, and we therefore support the Second Notice's proposals to introduce additional competition to the local transport element of the switched access market.

Four specific points were addressed in this comment. First, prohibiting entry into local transport services cannot be supported on economic efficiency grounds, and such entry should be accompanied by a requirement that LECs provide local loop access on a common carrier basis. Second, the price of switched access is substantially larger than (we estimate twice as large) its marginal cost. Third, substantial migration from switched access to special access will occur if implementing these proposed rules is significantly delayed. Fourth, some degree of pricing flexibility for the LECs is required to insure that only efficient entry occurs. We believe these findings generally support the FCC's proposals concerning expanded interconnection for interstate switched transport, as well as the FCC's tentative conclusion that expanded interconnection for switched access is likely to benefit consumers and promote competition.

References

Bell Communication Research, The Impact of End User Charges on Bypass and Universal Service September 1984.

Brennan, Timothy J., "Why Regulated Firms Should be Kept Out of Unregulated Markets: Understanding the Divestiture in U.S. v. AT&T," Antitrust Bulletin 32 (1987) 741-793.

Brittman, Michael K., Pehrsson, Kirston, M., and Rohlfs, J. H., Bypass and Growth of Demand for Switched Access Washington, DC: Shooshan and Jackson, Inc., DC 1989.

Brock, Gerald W., The Telecommunications Industry: The Dynamics of Market Structure Cambridge, MA: Harvard University Press, 1981.

Brock, Gerald W., "Bypass and the Local Exchange: A Quantitative Assessment," Federal Communications Commission, Office of Plans and Policy, Working Paper Series No. 12, Washington, DC, September 1984.

Brown, Stephen J. and David S. Sibley, The Theory of Public Utility Pricing New York, NY: Cambridge University Press, 1986.

Charnes, A., Cooper, W. W., and Sueyoshi, T., "A Goal Programming/Constrained Regression Review of the Bell System Breakup," Management Science 34 (1984) 1-26.

Christensen, L. R., Cummings, D.C., Schoech, P.E. "Econometric Estimation of Scale Economies in Telecommunications," in L. Courville, A. de Fountenay, and R. Dobell, eds. Economic Analysis of Telecommunications: Theory and Applications Amsterdam: North-Holland, 1983.

Crandall, Robert W., After the Breakup Brookings Institution: Washington, DC 1991.

Daley, George and Thomas H. Mayor, "Estimating the Value of a Missing Market: The Economics of Directory Assistance," 23 Journal of Law and Economics (1980).

Evans, D. S. and J. J. Heckman, "Multiproduct Cost Functions Estimates and Natural Monopoly Tests for the Bell System," in D. S. Evans, ed., Breaking Up Bell Amsterdam: North-Holland, 1983.

Faulhaber, Gerald R., Telecommunications in Turmoil Cambridge, MA: Ballinger Publishing Co., 1987.

Faulhaber, Gerald R., "Cross-Subsidization: Pricing in Public Enterprise," American Economic Review 65 (1975) 966-977.

Grandstaff, Peter J. and Watters, John S., "Switched Access Competition in U.S. Telephony: Evidence and Interpretation," Review of Business (Spring 1989) 19-26.

Griffen, James M., "The Welfare Implications of Externalities and Price Elasticities for Telecommunications Pricing," Review of Economics and Statistics 64 (1982).

Griffen, James M. and Thomas H. Mayor, "The Welfare Gain from Efficient Pricing of Local Telephone Services," Journal of Law and Economics 30 (1987) 465-496.

Jackson, C. L. and Rohlfs, J. H., Access Charging and Bypass Adoption Shooshan and Jackson, Inc., Washington, DC 1985.

Johnson, Leland, Competition and Cross-Subsidization in the Telephone Industry Santa Monica, CA: Rand Corporation, 1982.

Kasserman, David L., Mayo, John W. and Flynn, Joseph E., "Cross-Substitution in Telecommunications: Beyond the Universal Service Fairy Tale," Journal of Regulatory Economics 2 (1990).

Kahn, Alfred E. and Shew, William B., "Current Issues in Telecommunications Regulation: Pricing," Yale Journal on Regulation 4 (1987).

Landes, Wiiliam M. and Richard A. Posner, "Market Power in Antitrust Cases," Harvard Law Review 94 (1981).

Larson, Alexander C., Thomas J. Makarewicz, and Calvin S. Monson, "The Effect of Subscriber Line Charges on Residential Telephone Bills," Telecommunications Policy (1989) 337-354.

Larson, Alexander C. and Mudd, Douglas R., "Collocation and Telecommunications Policy: A Fostering of Competition on the Merits," California Western Law Review 28 (1992).

Mitchell, Bridger, "Incremental Costs of Telephone Access and Local Use," Santa Monica, CA: Rand Corporation, 1990.

Parsons, Steven G. and Ward, Michael R., "Bypass Incentives When Regulators Impose a Fixed Dollar Revenue Requirement for Access," Unpublished Manuscript (July 1991).

Parsons, Steven G. and Ward, Michael R., "Telecommunications Bypass and the 'Brandon' Effect," FTC Bureau of Economics Working Paper No. 199 (Feb 1993).

Rohlfs, Jeffrey, "Economically Efficient Bell System Pricing," Bell Laboratories Discussion Paper (1979).

Röller, L. H., "Modeling Cost Structure: the Bell System Revisited," Applied Economics 22 (1990) 1661-1674.

Sharkey, William W., The Theory of Natural Monopoly New York, NY: Cambridge University Press, 1982.

Shin, Richard, "Econometric Estimation of Telephone Costs for Local Exchange Companies," Ph.D. dissertation, University of California, Berkeley, (1988).

Shin, Richard and John S. Ying, "Unnatural Monopolies in Local Telephones," Rand Journal of Economics (1992).

Temin, Peter, The Fall of the Bell System New York, NY: Cambridge University Press, 1987.

U.S. Federal Communications Commission, Statistics of Communications Common Carriers, Washington, DC: U.S. Government Publishing Office, various years.

U.S. Federal-State Joint Board, Monitoring Report (CC Docket No. 87-339) Washington, DC, July, 1992.

United States Telephone Association, Bypass Study 1984.

Wenders, John T., The Economics of Telecommunications Cambridge, MA: Ballinger Publishing Company, 1987.

Wenders, John T. and Egan, Bruce L., "The Implications of Economic Efficiency for US Telecommunications Policy," Telecommunications Policy 10 (March 1986) 33-40.

Ying, John S. and Richard Shin, "Costly Gains to Breaking Up: LECs and the Baby Bells," Review of Economics and Statistics (1993).

WORKING PAPERS

Telecommunications Bypass

and the "Brandon Effect"

by

Steven G. Parsons
Southwestern Bell Telephone

and

Michael R. Ward
Federal Trade Commission

WORKING PAPER NO. 199

February 1993

BUREAU OF ECONOMICS
FEDERAL TRADE COMMISSION
WASHINGTON, D.C.

Telecommunications Bypass and the "Brandon Effect"*

Steven G. Parsons

Southwestern Bell Telephone

Michael R. Ward

Federal Trade Commission

February, 1993

Abstract: The creation of a charge for long distance companies to access the local telephone companies' switched network created the incentive to bypass the local switched network in order to avoid access charges that were substantially above cost. This paper explores the implications of a federal regulatory policy of a target total dollar switched access revenue requirement. In particular, the paper focuses on the so called "Brandon Effect" in which bypass incentives are attenuated when there is a target total dollar switched access revenue. Empirical analysis confirms the "Brandon Effect" on bypass decisions.

---

* The views expressed here do not necessarily reflect those of either Southwestern Bell Telephone or the Federal Trade Commission. This paper is an extension of Parsons and Ward (1991). We would like to thank Paul Brandon, Tim Daniel, Peter Griffes, Alex Larson, Doug Mudd, Bob Rogers, Richard Shin and Ken Troske for comments and suggestions and Dolly Howarth for research assistance.

1. Introduction

The divestiture of AT&T and the FCC's order on access charges accentuated a conflict between telecommunications policy and competitive forces. In particular, prior to the divestiture of AT&T, the price of long distance service gradually grew in order to offset a growing fraction of the cost of basic local telephone service assigned to long distance operations (Johnson (1982)). After 1983, the Federal Communications Commission (FCC) maintained this subsidy by requiring long distance companies to pay a per-minute-of-use fee as part of the switched access charge.[1] Since switched access charges are substantially in excess of local exchange company costs of providing switched access, competitive pressures are driving long distance companies to seek lower priced alternative means of connecting to end users; they are seeking to "bypass" the local switched network and its attendant charges.

Long distance companies purchase telephone access, usually from the Local Exchange Companies (LECs), since long distance networks generally do not reach customers' telephones. The decision to bypass essentially entails a comparison of the long distance companies' cost of bypass and the price of switched access provided by the LEC. Previous studies have focused on the lower cost of bypass for large and geographically concentrated customers (see, for example, Bellcore (1984), Britman, et al. (1989), Brock (1984), Grandstaff and Watters (1989), Jackson and Kuhlfs (1985) and USTA (1984)). In contrast, this study addresses the differences in the shadow price of switched access across long distance companies. Shadow and nominal prices for switched access could differ for a long distance company because its choice of access could affect the switched access price charged.

If the total long distance switched access revenue is known to be a constant sum, then (by regulatory fiat) a shift toward bypass from switched access by one firm will raise switched access prices for all firms. If the bypassing long distance company represents a small fraction of the switched access volume, most of the switched access price increase is borne by its competitors. If it represents a large fraction, the long distance company internalizes most of the switched access price increase. A long distance company's decision to bypass will depend,

---

[1] The long distance to local subsidy was reduced in 1985, when a Subscriber Line Charge was instituted as a recurring monthly charge to local service subscribers. However, SLC revenues currently make up only about a third of all interstate network access revenues.

in part, on the degree to which the attendant switched access price increase is internalized. Thus, larger long distance companies have lower shadow prices for switched access.

The attenuation of the long distance companies' incentive to bypass due to the regulators' desire to capture a fixed revenue requirement from switched access has been labeled the "Brandon Effect" after the AT&T executive who introduced the idea. Brandon (1982) is the first known reference of this phenomenon. Also, Brock (1984), on page 4, implies a variant when he states "If some companies bypass the switched access facilities and the revenue requirement to be provided by access remains constant, then access prices will be raised for the remaining customers. The higher prices will then induce further bypass and further increases until either equilibrium access price is reached . . . or all customers find alternatives to switched access." In Brock's scenario, regulators seek a fixed amount of revenue from access but the long distance companies do not consider this regulatory objective when they make bypass decisions. Katz and Willig (1985) model a version of the Brandon Effect in the context of determining if proposed long distance rates entail predatory pricing. Simnett (1988) captures a version of the Brandon Effect by constructing differing switched access shadow prices to AT&T and the other long distance companies, but he does not address the bypass implications. To our knowledge, no one has tested for the existence of the Brandon Effect.

The principle contributions of this paper are a mathematically explicit model of the Brandon Effect and an empirical verification of the existence and size of the Brandon Effect. Two variants of firm specific access/bypass demand substitution equations are estimated. The estimation procedures employed are extensions of existing instrumental variable methods for simultaneous systems of equations. The results do not uniformly confirm, but do suggest that regulators seek constant total dollar subsidies from long distance companies and these firms' bypass decisions reflect a Brandon Effect.

The next section describes some of the features of access provision in the telecommunications industry in more detail. Section 3 presents a simple model of bypass with an emphasis on the Brandon Effect and its implications. In this model, the long distance companies shadow price for switched access is equal to the nominal price times one minus the share of switched access purchased by the long distance company. Section 4 describes the testable hypotheses implied by the model and the data with which the tests were conducted. The fifth section

presents and discusses empirical findings for the existence and significance of the Brandon Effect. This is followed by a brief conclusion.

2. A Description of the Access Market

A long distance telephone company operates a communications network that connects local telephone exchanges, hence, it is called an Interexchange Carrier (IC). The LECs, such as the regional Bell Operating Companies and GTE, transport long distance telephone calls between customers' premises and the nearest termination point of an ICs' network. These services are collectively called carrier access and represent nearly half of all IC costs. AT&T's 1984 divestiture effectively precluded the Bell operating companies from offering long distance service.

States regulate prices for intrastate services, and the FCC regulates prices for interstate services, such as interstate switched access. Until recently, ICs and LECs operated under rate-of-return regulation.[2] To accomplish joint regulatory oversight, some LEC assets are allocated to the intrastate and interstate jurisdictions for cost recovery in a necessarily arbitrary way. The costs assigned to the interstate jurisdiction are primarily recovered through a switched access charge on each minute of long distance connection and, beginning in 1985, a Subscriber Line Charge billed as a flat rate monthly charge on each telephone line.[3]

In *Smith v. Illinois Bell Tel. Co.* (1930), the courts ruled that since AT&T's long distance service used the local exchange network, a portion of the cost of the local network should be recovered through long distance rates. The portion of the local network assigned to long distance service steadily grew to 27% in 1982[4] with little relation

---

[2] The FCC began development of the AT&T Price Cap Plan in 1987 with Policy and Rules Concerning Rates for Dominant Carriers, CC Docket No. 87-313, Notice of Proposed Rulemaking, 2 FCC Rcd 5208 (1987). Price cap regulation for AT&T took effect in July, 1989. As a result of the FCC's Second Report and Order in CC Docket 87-313 released October 4, 1990, price caps for LECs became effective January 1, 1991. However, the LECs are still strongly tied to rate-of-return regulation, because earnings above certain thresholds results in lower future LEC prices and, thus, rates-of-return.

[3] Most special access, as well as some smaller revenue services, are also assigned to the interstate jurisdiction.

[4] Originally the proportion of the local network costs assigned to long distance operations was the fraction of calls going over long distances. In the early 1950s, this was less than 3% and by 1982 it was 8%.

to underlying economic costs.[5] The FCC's 1983 Access Charge Plan formalized this cost assignment and cost recovery mechanism with an additional charge, called a Carrier Common Line Charge, on the switching function of switched access. At first, the non-AT&T ICs had "nonpremium" connections to the LECs (e.g., customers were required to dial extra digits to reach non-AT&T ICs); the additional charge for nonpremium access was set at 45% of that for premium service obtained by AT&T. The divestiture agreement required the LECs to install equipment to provide equal access to any IC asking for it. The equal access equipment is currently in place for nearly all (91%) IC customers.[6]

In devising its access charge plan, the FCC eventually recognized that if usage-sensitive access charges greatly exceeded marginal costs, ICs and high volume customers would have an incentive to make alternate connections between the customer's premises and the IC's network in order to bypass the LEC and avoid switched access charges. Thus, the FCC decided that part of the basic local exchange costs allocated to the interstate jurisdiction should be recovered through a fixed recurring monthly Subscriber Line Charge billed to the customer rather than the usage sensitive switched access charges billed to the IC.[7] Economists had argued that these costs were incurred because customers had access to the network and did not rise with usage, thus movement toward a recurring monthly charge increased efficiency by aligning prices more closely with costs.[8] A Subscriber Line Charge was gradually instituted[9] that lowered switched access charges but did not eliminate them. In 1984, the average switched access price was $.173 per conversation minute; by 1991 it was $.072 (U.S. Federal-State Joint Board (1991).

---

[5] See also, Temin and Peters (1985a, 1985b), Griffen (1982), Kasserman, Mayo and Flynn (1990), Kahn and Shew (1987) and Johnson (1982). With respect to the history of deregulation and telecommunications policy, see generally, Brock(1981), Faulhaber (1987), Temin (1987) and Larson and Mudd (1992).

[6] However, nonpremium service still accounts for 5% of OCC service and 20% of the ICs do not purchase premium service from Bell Operating Companies (Statistics of Communications Common Carriers (1991)).

[7] The Subscriber Line Charge was established in CC Dockets 78-72, and 80-286 93 FCC 2d 241 (released February 28, 1983).

[8] See Temin (1987) on the FCC's 1983 Access Charge Plan and Wenders (1987) and Wenders and Egan (1986) on efficient pricing for access. Also see Kahn and Shew (1987).

[9] The Subscriber Line Charge has leveled off at a maximum monthly rate of $3.50 per line for residential and single line business service and $6.00 per line for multi-line business service.

The threat of bypass resulted in prices for access that more closely reflect the cost of service. One response to this threat was the imposition of the Subscriber Line Charge and concurrent reductions in switched access charges. Special access prices are based on circuit capacity rather than actual use, as with switched access, and can be thought of as volume discounts for large and more demand elastic customers. Switched access rates are averaged over geography and density, with substantial differences in the LEC's cost of service. Bypass has generally occurred where the cost of providing alternate access is the lowest. LECs have asked regulators for the ability to set prices closer to actual costs in response to bypass competition. Originally, the competition was relegated to the provision of dedicated carrier access. However, third-party access providers have asked regulators for interconnection to LEC facilities primarily to offer switched transport service. If such interconnection is granted, both the value of third-party-provided access and competition for access will increase.

Bypass of switched access falls into three categories: totally private networks, the use of non-LEC facilities bypass between end users and ICs, and the use of LEC special access facilities between end users and ICs. A number of totally private networks have been built. These were generally constructed for data communications or other specialized needs however. Such networks are of tertiary significance as factor inputs for ICs and, therefore, for our purposes, they are of little concern. Facilities bypass can occur through an IC or customer owned line, but it is increasingly obtained through third-party providers. Third-party or alternate access providers construct localized fiber optic networks, usually in downtown or other business districts, which are connected to the ICs' networks. Special access lines provided by the LECs are used for data and point-to-point private line service, as well as switched access charge avoidance. Although special access is thought to currently account for 70-80 percent of total bypass (U.S. Federal-State Joint Board (1991)), facilities bypass is sufficient to hold LEC prices in check.

Special access is purchased for a variety of uses, not all of which are consistent with switched access charge avoidance. For instance, broadcasters lease audio and video transmission lines to link up to each other and to their affiliated network. Also, computer communications are enhanced by digital data lines. These services require features that switched access cannot provide (high speeds and digital transmission), and, in fact, they often do not benefit from the ability to be switched. While data communications is growing, it does not represent a substantial portion of the total LEC-handled traffic.

The types of special access more suited to switched access charge avoidance are voice grade lines, WATS lines, and DS1 (high capacity) connections. Voice grade lines and WATS lines are specifically designed to carry voice traffic. DS1 connections have greater capacity, enabling up to 24 simultaneous voice-grade connections. A higher capacity connection, DS3, is essentially equivalent to 28 DS1 connections. However, quantity data for DS3 connections were unavailable for this study. WATS lines are a hybrid of special and switched access, since customers are charged a monthly fee and a usage fee for local transport and switching but are not charged the Carrier Common Line Charge. High speed data communications also use DS1 connections. The fraction of DS1 connections used for data transmission is unknown however. While the mix of special access services changed since 1988, in aggregate, voice-grade lines, WATS lines and DS1 connections comprise the great majority of special access use for the time period of the data used in this study.

3. A Model of Inter-Exchange Carrier Bypass Incentives

The term "bypass" has been used to describe many activities; in this paper it is defined somewhat more narrowly. The bypass decisions addressed here pertain to the method of connection the IC chooses for an end user. For each customer connection, ICs are assumed to choose either to purchase switched access or bypass the LEC switched network. An IC bypasser can build dedicated facilities between the IC's network and the customer's premises, or it can gain connection through the lease of a dedicated line, usually from the LEC under a special access arrangement. Both of these bypass alternatives represent continued use of the IC's network.

ICs are assumed to choose factor input levels to minimize the total costs, C, of providing a certain level of service to their end users. Let i index ICs. If switched access, A_i, and bypass, B_i, are closely substitutable factor inputs, then the IC_i will purchase these inputs in the proportion that equates their marginal costs,

$$\frac{\partial C_i}{\partial B_i} = \frac{\partial C_i}{\partial A_i}. \tag{1}$$

Initially, the marginal cost to the IC of switched access is assumed to be a fixed constant, ordinarily its nominal price. The marginal cost of bypass is increasing with the amount of bypass.[10] Equation (1) has an interior solution if the marginal cost of bypass is below the marginal cost of LEC access for the first customer and above that for the last.

Let r be the price of switched access and c be the constant marginal cost to the LEC of providing this access. Then total switched access expenditures for IC_i are $r A_i$ and marginal IC costs of LEC switched access are

$$\frac{\partial C_i}{\partial A_i} = r + A_i \frac{dr}{dA_i}. \tag{2}$$

The derivative dr/dA_i is determined by assuming that the total revenue, R, from switched access is constant, and the price is determined by dividing switched access revenue by the total switched access demanded, $r = R / \Sigma_j A_j$. The effect of a change in A_i on r is derived by r differentiated with respect to A_i while holding R and A_k constant for $k \neq i$, so that

$$\frac{dr}{dA_i} = -\frac{R}{(\Sigma_j A_j)^2} = -\frac{r}{\Sigma_j A_j}. \tag{3}$$

Finally, combining equations (1), (2) and (3) yields:

$$\frac{\partial C_i}{\partial B_i} = r(1 - w_i), \tag{4}$$

where w_i is IC_i's share of switched access, $w_i = A_i / \Sigma_j A_j$.

---

[10] The marginal cost to the IC of bypass along any particular route is likely to decrease with respect to the quantity of calls or even bypass circuits along that route. The marginal cost of bypass will be increasing as routes are added; additional routes will be longer with less traffic.

Equation (4) indicates that ICs choose the level of switched access and bypass such that the marginal cost of bypass is equated with a value which can be less than the price of switched access. Moreover, this shadow price varies inversely with the IC's share of LEC switched access. In essence, a fixed revenue level for LECs from switched access causes an IC to have a diminished incentive to bypass, and this effect is greater for a larger IC. Consider the monopsonist IC and the fringe IC as polar opposites. A monopsonist IC ($w_i = 1$) has a shadow price of switched access equal to zero and the revenue is transferred as a lump sum tax. The fringe IC ($w_i \approx 0$) has a shadow price close to the full switched access price, r.

The source of the difference in shadow prices between small and large ICs is important to understand. This form of regulation, seeking a constant dollar amount of switched access revenue, confers a strategic compliment attribute to switched access. As one IC uses more switched access, the switched access price to all users falls, and thus, all ICs' costs fall. As an IC's share of switched access rises, the portion of the complementarily that is internalized also rises. For a switched access monopsonist, this complementarity is completely internalized; for a fringe competitor it, is trivial to its decision process.

This model is, of course, a simplification of the actual market for access, and real world factors may abrogate the Brandon Effect. Some of the more obvious potential criticisms will be considered and reconciled with the model presented. These criticisms stem from: the different means of bypassing switched access charges, the potential endogeneity of the switched access share and the move toward price-cap regulation.

First, bypass in the model applies to all forms of switched access avoidance, but, in the tests below, bypass is identified with special access. The important issue is whether, absent the Brandon Effect, the size of the IC will greatly affect the choice of the form of bypass. LEC provided special access is often provided in the same way with the same technology as third-party or IC-provided facilities bypass. Special access should be an excellent proxy for bypass in total. In addition, as noted earlier, special access constitutes the great majority of bypass.

Second, the analysis takes IC switched access shares as exogenous, yet the Brandon Effect could be a determinant of the shares. The feedback would tend to increase IC switched access share differentials, since smaller ICs are more likely to opt for bypass instead of switched access. The endogeneity is likely to be small relative to the effects of other factors in the telecommunications industry during this time period however (e.g., IC price

differentials). Since AT&T's share of switched access has fallen dramatically, this feedback appears to be small relative to other factors. In addition, because the feedback would cause an accentuating rather than countervailing effect, the model can still be unambiguously tested.

Third, the move to "price-cap regulation" at the Federal level does not affect the applicability of the analysis. AT&T's incentives toward bypass should not have changed substantially when rate-of-return regulation was replaced by "price-cap regulation." LECs have only faced "price-cap regulation" since January of 1991.[11] Moreover, in both cases, the form of "price-cap regulation" adopted contains strong rate-of-return features through sharing mechanisms beyond certain rate-of-return levels. The fixed dollar revenue framework still exists.

4. Empirical Tests

The analysis above implies that the relevant switched access price measure to ICs is not the posted nominal price. The shadow price depends on the nominal price and the IC's relative share of all switched access. The determinants of IC access demand and supply are estimated in order to conduct two tests of this hypothesis. First, a test for positive correlation between switched access demand and switched access share of expenditures, *ceteris paribus*, is conducted. This is performed by a t test in a multiple regression. Second, specification tests comparing a demand model employing the shadow price of switched access to a demand model employing the nominal price are conducted using a series of nonnested J tests.

The principle data source for these tests is proprietary to Southwestern Bell Telephone Co., obtained under a nondisclosure agreement. These data are monthly purchases from January 1989 through December 1991 of switched and special access usage from Southwestern Bell by various ICs for each state in which Southwestern Bell operates.[12] Data are generally available for AT&T, MCI, Sprint and an aggregation of all other carriers. Special access quantity data exist only for AT&T and the aggregation of non-AT&T carriers (called the Other Common Carriers or OCCs). The variables available are revenues and quantities of both switched and special access usage.

---

[11] Price-caps for LECs were established in CC Docket No. 87-313 (Released Oct. 4, 1990).

[12] These are Arkansas, Kansas, Missouri, Oklahoma, and Texas.

Since special access is the primary mode of switched access avoidance, it is used as a surrogate for total bypass. Also available, but not at the individual IC level, are price indices for switched and special access for each month and state. Information on the demand for long-distance service and cost of inputs into the production of access are also used.

Estimating individual factor demand equations for switched and special access is problematic for two reasons. First, the data are not rich enough to estimate reliably the necessary parameters. The prices of both factors of production are likely to enter both factor demand equations. Since these prices are likely to be endogenous, separate instrumental variables would be required for each price variable. Such instrumental variables are not available. Second, the switched access expenditure share by IC, a key explanatory variable, is almost surely correlated to the level of switched access demand. Again, the advisable strategy is to find instrumental variables for the share. However, it is difficult to imagine a variable that affects this share that does not belong in the demand equation itself.

Alternatively, the ratio of the factors of demand is estimated as a function of the ratio of factor prices and other variables. The coefficient of the price ratio yields an elasticity of substitution between switched access and bypass. Using this approach, instrumental variables are needed for only one variable, the price ratio, at the cost of the assumption of a constant elasticity of substitution. An IC's relative factor proportions of switched access and bypass is not likely to be affected by the IC's share of total switched access expenditures (other than through the shadow price of switched access). Thus, for AT&T and the OCCs,

$$\frac{QtySwAcc_{kt}^{ATT}}{QtyBypass_{kt}^{ATT}} = f^{ATT}\left[\frac{PrcSwAcc_{kt}^{ATT}}{PrcBypass_{kt}^{ATT}}, SwAccShr_{kt}^{ATT}, X_{kt}\right] + \epsilon_{kt}^{ATT} \tag{5}$$

$$\frac{QtySwAcc_{kt}^{OCC}}{QtyBypass_{kt}^{OCC}} = f^{OCC}\left[\frac{PrcSwAcc_{kt}^{OCC}}{PrcBypass_{kt}^{OCC}}, SwAccShr_{kt}^{OCC}, X_{kt}\right] + \epsilon_{kt}^{OCC} \tag{6}$$

are estimated, where X is a vector of exogenous factor demand shifting variables and k and t subscript state and month.

Economists often assume that factor input prices are determined exogenously from factor demand determination. However, for two different reasons, the price ratios in equations (5)-(6) could be endogenous to the quantity ratios. First, either the LEC could exercise market power in switched access usage or AT&T could exercise a degree of monopsony power. If either of these is the case, price will be a function of the quantity demanded. Second, both prices in these ratios are set by regulators seeking revenues to "recover" fixed costs; if demand decreases, prices will rise in order to satisfy the fixed total revenue level or fixed revenue requirement. Indeed, this is exactly the type of assumption necessary for the existence of the Brandon Effect. Thus, supply price determination equations,

$$\frac{PrcSwAcc_{kt}^{ATT}}{PrcBypass_{kt}^{ATT}} = g^{ATT}\left[\frac{QtySwAcc_{kt}^{ATT} + QtySwAcc_{kt}^{OCC}}{QtyBypass_{kt}^{ATT} + QtyBypass_{kt}^{OCC}}, Z_{kt}\right] + \nu_{kt}^{ATT} \tag{7}$$

$$\frac{PrcSwAcc_{kt}^{OCC}}{PrcBypass_{kt}^{OCC}} = g^{OCC}\left[\frac{QtySwAcc_{kt}^{ATT} + QtySwAcc_{kt}^{OCC}}{QtyBypass_{kt}^{ATT} + QtyBypass_{kt}^{OCC}}, Z_{kt}\right] + \nu_{kt}^{OCC} \tag{8}$$

are also estimated, where Z represents a vector of exogenous LEC supply shifting variables correlated with the price ratio. Equations (5)-(8) form a system of simultaneous equations to be estimated by instrumental variables techniques.

Data Description

The data available provide measures of quantity and price ratios from which equations (5)-(8) can be estimated. The appendix provides a description of the construction of the variables used in this study. Actual expenditures are divided by actual quantities to obtain average prices for switched and special access demand. The ratio of the actual quantities can be regressed against the ratio of these average prices paid. This construction suffers because aggregating various forms of special access is problematic. The most common types of special access used to avoid switched access charges are single line WATS/voice grade connections and multiple circuit DS1 connections. DS1 trunks can handle up to 24 different voice grade lines (they are also used for high speed data transmission), but since additional charges are incurred as additional lines are activated, often some lines are left

unused. Concrete data on the average number of lines used per DS1 trunk does not exist; however, conversations with Southwestern Bell experts lead us to believe that, on average, approximately 16 circuits are used per DS1 connection. Obviously, this number can vary over time, across ICs, or across states; unfortunately, however, we have no information on the size or direction of the variation. Thus, special access lines are aggregated as the sum of the WATS lines, voice-grade lines and 16 times DS1 lines. The benefit of this construction is that digital data lines are not included and the price measures are specific to the IC.

The construction of the switched access share variable requires some discussion. First, while the switched access share for AT&T is directly calculated as AT&T's switched access expenditure divided by total switched access expenditure, the corresponding value for the OCCs is slightly more complicated. The switched access share for the OCCs is calculated as the weighted average of the individual share's for MCI, Sprint and other ICs, where the weights are the fraction of OCC expenditure represented by MCI, Sprint or the other ICs. Furthermore, since the other ICs share itself constitutes an aggregation of many small firms, its share is divided by ten in order to approximate their average share. Second, the switched access share of revenue is possibly correlated with the ratio of switched to special access quantity by construction (rather than due to the Brandon Effect). To avoid this occurrence, for each IC and state in the sample, the IC's average share over the other four states is substituted.

The variables in X, those that shift factor demand for switched access relative to special access, include variables affecting end-user demand and variables measuring the level of other IC factor inputs. Real disposable income per capita is used to capture income effects and the number of residential and nonresidential lines are included to reflect the size of these markets. Bypass is much more likely to occur in the provision of IC service to business rather than residential customers; business customers in different industries have greater opportunities for bypass based on their use of telecommunications. To measure these industry differences, the number of employees in each of eight broad industry categories are included as possible demand-shifting variables. While the costs of other IC factor inputs could affect the switched access to special access ratio, only data reflecting the average cost of debt from the yields to maturity on the AT&Ts' corporate bonds are available.

The variables in Z, those that shift the relative prices of switched and special access, include prices of inputs into the production of both types of access, the Subscriber Line Charge (SLC), and other variables intended

to capture the workings of the regulatory process. For prices of inputs into the production of access, the wage of telecommunications workers, the cost of debt for Southwestern Bell and the prices of nonbroadcast communications transmission equipment and central office switching equipment are used. Since the SLC was intended to partially replace the switched access charge as a method of local loop cost recovery, increases in the SLC are expected to be concurrent with decreases in the price of switched access. Other regulatory variables include "excess" returns to LEC switched and special access, and the equity income of large long distance companies and LECs. "Excess" returns (actual returns above the target or allowed rate of return) are expected to lead to lower access prices in the subsequent rate order. Finally, an increase in the switched access price can be thought of as a transfer from ICs to LECs. If regulators are interested in maintaining the financial viability of both types of companies, then past financial distress of LECs (ICs) will lead to future higher (lower) switched access prices (regulators are assumed to have much less discretion with special access prices). Financial distress is measured for ICs and LECs as the income (both dividends and capital gains) generated by holding stock in a portfolio including AT&T and MCI and the seven regional Bell Holding Companies respectively. In order to allow for a form of regulatory lag, all of these variables, except the SLC, are computed as moving averages of values over the past six months.

Estimation Issues

The applicability of instrumental variables methods to the existing data has already been noted. Specifically, the variables exogenous to the system, X and Z, are used as instruments. First stage regression results are not reported.

Other estimation issues include possible autocorrelation and heteroskedasticity. Existence of either of these problems will lead to inefficient estimation and biased standard errors, rendering inference testing problematic. First, estimated correlations between the error term and lags of the error term for the same state indicate that autocorrelation is present. Autocorrelation is corrected for by quasi-first differencing the data. Second, since an observation represents the average across individuals in a state, and the states in the sample have significant variation in population, the standard error of a variable for a large state will be smaller than for a small state. This leads to a smaller variance of the standard error of the regression for large states relative to small states. The remedy

employed here for this form of heteroskedasticity is to weight observations by the population of the state it represents.

Almost all variables included in the regressions are the natural logarithm of the underlying variable; the exceptions, the net income and "excess" returns variables in the price equations, are due to the existence of negative values of these variables. Thus, coefficient estimates usually can be interpreted as elasticities and, specifically, the coefficient on price in the quantity equations is interpreted as the elasticity of substitution. The magnitude of the coefficients on the net income and "excess" returns are more difficult to interpret.

5. Empirical Results

This section presents results from estimation of equations (5)-(8) and nonnested tests. Generally, tests strongly, but not uniformly, confirm the presence of the Brandon Effect.

Regression Results

Table 1 reports two stage least squares (2SLS) coefficient estimates of equations (5)-(8). Durbin-Wu-Hausman tests reject at a high confidence level the hypothesis that endogeneity between the price ratio and the quantity ratio will not cause OLS estimates to be inconsistent (Hausman (1978)). The specification presented is the result of a number of specification tests.

In the quantity-ratio equations, the price ratio enters negatively and the switched access share enters positively for both AT&T and the OCCs. However, these coefficients are significant only for AT&T. The t tests on the switched access share confirm the existence of the Brandon Effect, at least for AT&T. Also, the shadow price of switched access is inversely related to the switched access share, suggesting that the elasticity of substitution defined for shadow prices is larger (in absolute terms) than the coefficient of the price ratio suggests. A larger shadow price elasticity of substitution is confirmed below.

Since the dependent variable is the quantity ratio, coefficients on other explanatory variables measure the effect of these variables on factor demand for switched access relative to the factor demand for special access. An insignificant coefficient could imply that the variable does not have an appreciable effect on factor demand.

Alternatively, insignificance could be interpreted as implying that the magnitudes of these variables for switched and special access are comparable.

Higher per capita income increases the demand for switched access relative to special access for both AT&T and the OCCs. The cost of debt (measured as the yield to maturity on corporate bonds) has no effect for either AT&T or the OCCs. The effect of residential and nonresidential lines have opposite effects for AT&T and the OCCs. A greater number of residential lines decreases the switched- to special-access ratio for AT&T and increases it for the OCCs. However, a greater number of nonresidential lines increases the switched to special access ratio for AT&T and decreases it for the OCCs. These nonresidential lines are almost exclusively nonspecial access business lines. Since businesses tend to use more long distance than residences and long distance service over these lines entails switched access, a positive coefficient is expected.

Measures of employment in different sectors of the state's economy are intended to capture differences in demand by long distance customers. Generally, coefficients tend to have the same signs for both AT&T and the OCCs. A positive (negative) coefficient indicates that the sector uses more (less) switched access relative to special access than the average sector. Construction and transportation and public utilities use relatively more switched access, while trade, and, perhaps, finance, insurance and real estate and services, use relatively more special access. Since larger telecommunications users (and the ICs that serve them) have the best opportunity and motive for bypass, more of these users are expected to increase the relative share of special access. Our results are consistent with this expectation, since many of the most telecommunications intensive sectors reported by Crandall (1991) can be classified as trade and finance, insurance and real estate.[13]

The coefficients also tend to have the same sign for both AT&T and the OCCs in the price ratio equation. The quantity ratio enters negatively and significantly as expected if regulators attempted to maintain a constant amount of revenue for LECs from switched access. The coefficient of the SLC is positive, contrary to expectation, but not significant. The cost of debt and the price of transmission equipment raise the price of switched access relative to special access, while the price of central office switching equipment lowers it. Industry wages have no

[13] The telecommunications intensive sectors reported in Crandall (1991) are financial services; retail and wholesale trade; hotels and motels; health, education, and social services; transportation; eating and drinking places; real estate and rentals.

effect on relative prices. The excess returns coefficients generally have the expected signs. High past special (switched) access excess returns tend to decrease the relative price of special (switched) access. However, the equity income coefficients have mixed signs and never approach significance.

Nonnested Tests

Next, nonnested J tests (Davidson and MacKinnon (1981)) of the nominal price versus the shadow price constructed as one minus the IC's switched access share times the nominal price ratio are presented. The competing hypotheses are that the nominal and shadow price ratio constructions describe the process that generated the data. Since the log of the switched to special access price ratio is not linearly nested within the log of the shadow price ratio, nonnested testing techniques are appropriate.

Generally, nonnested tests attempt to distinguish between two models of the data where neither model is a linear extension of the other (e.g. nominal versus shadow price). This is accomplished by artificially nesting both hypothesized models within a more general model. The dependent variable is regressed against one model plus α times the other model. However, when the two models share some exogenous variables, this leads to an underidentified equation. The solution is to replace the unknown parameters of the model not being tested with consistent estimates, usually the predicted values from this model's specification. A t test on whether α is different from zero indicates whether the information in the predicted values helps "explain" the data. An α different from zero implies that, without this information, the model being tested is missspecified. By reversing which model's predicted values are included, both specifications can be tested. With these procedures, it is possible to reject neither model or to reject both as missspecified.

In the present application, the possible endogeneity of the switched access share can also be better addressed by the use of J tests. Because the switched access share could be correlated with the error terms by construction, equations (5) and (6) use the ratio of switched to special access demand as the dependent variable and switched access shares for one state were computed using information from the other states. This purges the variables of much of the presumed spurious correlation. In the J test specifications, the switched access shares are incorporated

in the shadow prices and these, in turn, are projected onto the instrumental variables. These instrumental variables purge both the nominal price and the switched access share of their possible correlation with the error term.

Table 2 reports the J test results. The nominal price model is rejected for AT&T but not for the OCCs, and the shadow price model is not rejected for either AT&T or the OCCs. These tests imply that either the nominal price or the shadow price describe the data for the OCCs, but only the shadow price describes the AT&T data. The failure to reject either model for the OCCs is probably linked to the relatively small variation in the switched access share for the average OCC firm. For the OCCs, the constructed shadow price ratio and nominal price ratio are highly correlated.

Given these results, examining the price ratio coefficients in the competing models is enlightening. These are reported in table 3. Coefficients for X are not reported but remain virtually unchanged from table 1. For the OCCs, there is little difference in the estimated price elasticities. For AT&T, the estimated elasticities are somewhat greater (in absolute terms) for the shadow price model than for the nominal price. This is to be expected if the Brandon Effect guides AT&T decision-making.

Other Specifications

Two other specifications of the data were also tested with qualitatively the same results. First, as discussed above, WATS service only avoids a portion of the switched access charges. Equations (5)-(8) were estimated with WATS lines excluded from the special access quantity with nearly identical results. Second, Southwestern Bell constructs indices of switched and special access prices aggregated across all purchasers that provide an independent measure of the switched to special price ratio. Also, these indices provide a different measure of quantity by dividing access revenue by the relevant price index. Specifications using these price and quantity indices yielded results which were less precise, but, nonetheless, similar to those reported above.

6. Conclusion

This paper describes, models and tests for the so-called Brandon Effect. This effect arises when the price for an input with close substitutes is set above marginal costs so as to generate a fixed dollar amount of revenue

to the seller. The model presented is simple and similar to (although more explicit than) descriptions presented elsewhere. The formula for an IC's shadow price for switched access is deduced from the model as the nominal price times one minus the IC's share of the total switched access demand. Tests for the Brandon Effect center on whether switched access share has the expected effect on the demand for switched access. While the test results presented do not uniformly confirm this hypothesis, they clearly support it.

The results raise issues for business and public policy. First, models of bypass behavior that ignore the Brandon Effect are likely to overstate actual levels of bypass, particularly bypass by AT&T. Second, over time as AT&T's share of total switched access falls, AT&T's shadow price of switched access will rise and its incentive to bypass will increase. The incentive to bypass by MCI and Sprint will fall over time as their switched access shares rise. Third, regulatory policy changes that render a constant dollar revenue target unrealistic or unattainable would eliminate the Brandon Effect mechanism. A true form of price-caps or incentive regulation (without rate-of-return elements) would eliminate the switched access fixed dollar framework. Likewise, competition from third-party access providers could erode the market power necessary to achieve the fixed dollar amount if they are granted favorable LEC interconnection opportunities by regulators. In either case, the incentive to bypass would increase for all ICs because nominal prices, and not the lower shadow switched access prices constructed above, would reflect true opportunity costs.

Aside from direct tests for the existence of the Brandon Effect, this paper raises some issues for access demand estimation. Often, access demand estimates for regulatory proceedings are derived from single equation OLS models.[14] The empirical work presented here suggests that both the price of switched access and the price of special access are endogenous to the quantity of switched access demanded. Single equation models that ignore these effects could be missspecified, leading to inconsistent estimates.

---

[14] See Gatto, et al. (1988) and the studies cited therein.

References

Bell Communication Research, *The Impact of End User Charges on Bypass and Universal Service* September 1984.

Bradley, Stephen P. and Hausman, Jerry A. ed., *Future Competition in Telecommunications* (Harvard Business School Pres, Boston, MA 1989).

Brandon, Paul S., "NTS Separations Allocators: Usage-Based or Usage Independent," AT&T Tariffs and Costs; June 1, 1982 Unpublished Manuscript.

Britman, Michael K., Pehrsson, Kirston, M., and Rohlfs, J. H., *Bypass and Growth of Demand for Switched Access* Shooshan and Jackson, Inc., Washington, DC 1989.

Brock, Gerald W., *The Telecommunications Industry: The Dynamics of Market Structure* (Harvard University Press, Cambridge, MA 1981).

Brock, Gerald W., "Bypass and the Local Exchange: A Quantitative Assessment," Federal Communications Commission, Office of Plans and Policy, Working Paper Series No. 12, Washington, DC September 1984.

Crandall, Robert W., *After the Breakup* (Brookings Institution, Washington, DC 1991).

Davidson, R. and MacKinnon, J., "Several Tests for Model Specification in the Presence of Multiple Alternatives," *Econometrica* 49 (1981) 781-793.

Faulhaber, Gerald R., *Telecommunications in Turmoil* (Ballinger Publishing Co., Cambridge, MA 1987).

Gatto, Joseph P., Langin-Hooper, Jerry, Robinson, Paul B. and Tyan, Holly, "Interstate Switched Access Demand Analysis", *Information Economics and Policy* 3 (1988) 333-358.

Grandstaff, Peter J. and Watters, John S., "Switched Access Competition in U.S. Telephony: Evidence and Interpretation," *Review of Business* (Spring 1989) 19-26.

Griffen, James, "The Welfare Implications of Externalities and Price Elasticities for Telecommunications Pricing," *Review of Economics and Statistics* 64 (1982).

Hausman, Jerry A. "Specification Tests in Econometrics," *Econometrica* (Nov. 1978) 1251-1272.

Jackson, C. L. and Rohlfs, J. H., *Access Charging and Bypass Adoption* Shooshan and Jackson, Inc., Washington, DC 1985.

Johnson, Leland, *Competition and Cross-Subsidization in the Telephone Industry* The Rand Corporation, Santa Monica, CA 1982.

Kasserman, David L., Mayo, John W. and Flynn, Joseph E., "Cross-Substitution in Telecommunications: Beyond the Universal Service Fairy Tale," *Journal of Regulatory Economics* 2 (1990).

Kahn, Alfred E. and Shew, William B., "Current Issues in Telecommunications Regulation: Pricing," *Yale Journal on Regulation* 4 (1987).

Katz, Michael and Willig, Robert D., "The Effects of Capped NTS Charges on Long Distance Competition," mimeo (1985).

Larson, Alexander C. and Mudd, Douglas R., "Collocation and Telecommunications Policy: A Fostering of Competition on the Merits," *California Western Law Review* 28 (1992).

Parsons, Steven G. and Ward, Michael R., "Bypass Incentives When Regulators Impose a Fixed Dollar Revenue Requirement for Access," Unpublished Manuscript (July 1991).

Rohlfs, Jeffrey, "Economically Efficient Bell System Pricing," Bell Laboratories Discussion Paper (1979).

Simnett, Richard E., "Contestable Markets and Telecommunications," in *Deregulation and Diversification of Utilities*, Michael A. Crew (ed.) (Kluwer Academic Publishers Boston, MA, 1988).

Taylor, Lester D., *Telecommunications Demand: A Survey and Critique* (Ballinger Publishing Company, Cambridge, MA 1980).

Temin, Peter, *The Fall of the Bell System* (Cambridge University Press, New York NY 1987).

Temin, Peter and Peter, Geoffrey, "Cross-Substitution in the Telephone Network," *Willamete Law Review* 21 (1985a).

Temin, Peter and Peter, Geoffrey, "Is History Stranger than Theory? The Origins of Telephone Separations," *Economic History* 75 (1985b).

U.S. Federal Communications Commission, *Statistics of Communications Common Carriers*, Washington, DC: U.S. Government Publishing Office, various years.

U.S. Federal-State Joint Board, *Monitoring Report* (CC Docket No. 87-339) Washington, DC, January 1991.

United States Telephone Association, *Bypass Study* 1984.

Weisman, Dennis L., "Default Capacity Tariffs: Smoothing the Transitional Regulatory Asymmetries in the Telecommunications Market," *Yale Journal on Regulation* 5 (1988) 149-178.

Weisman, Dennis L. and Kridel Donald J., "Forecasting Competitive Entry: The Case of Bypass Adoption in Telecommunications," *International Journal of Forecasting* 6 (1990) 65-74.

Wenders, John T., *The Economics of Telecommunications* (Ballinger Publishing Company, Cambridge, MA 1987.

Wenders, John T. and Egan, Bruce L., "The Implications of Economic Efficiency for US Telecommunications Policy," *Telecommunications Policy* 10 (March 1986) 33-40.

Appendix Definitions of Variables

Ratio of Switched to Special Access Quantity - is the number of minutes of use (MOU) of switched access divided by the number of lines of special access. The number of special access lines was computed as the sum of WATS, voice grade and sixteen times DS1 (source: Southwestern Bell).

Ratio of Switched to Special Access Price - is the ratio of the average expenditure per MOU of switched access divided by the average expenditure per line of special access. Special access expenditures used here are total special access expenditures minus an estimate of digital data expenditures. The number of special access lines was computed as the sum of WATS, voice grade and sixteen times DS1 (source: Southwestern Bell).

Switched Access Share - is the ratio of the IC's switched access expenditures to the sum of all IC switched access expenditures. To avoid possible spurious correlation with the dependent variable, the ratio for any state is defined as this ratio computed for expenditures in all other states (source: Southwestern Bell).

Residential and Non-Residential Lines - are the number of residential and non-residential lines Southwestern Bell serves in the state (source: Southwestern Bell).

Income per capita - is disposable personal income per capita in the state for the quarter (source: Survey of Current Business).

Cost of Debt - is the average real yield to maturity on the firms' corporate bonds. Conversion from nominal to real rates was accomplished by deflating a bond's yield to maturity by the yield to maturity on a comparably lived government bond (source: Moody's).

Employment in a sector of the economy - is the number of people employed in the sector in the state. The eight sectors are: Mining; Construction; Manufacturing; Transportation and Public Utilities; Finance, Insurance and Real Estate; Services; and Government (source: Employment and Earnings).

Subscriber Line Charge - is the real national average subscriber line charge (source: Monitoring Report).

Telephone Worker Wage - is the real wage of nonprofessional telecommunications workers (source: Employment and Earnings).

Price of Central Office Switching Equipment and Transmission Equipment - are real price indices for central office switching equipment and non-broadcast communications transmission equipment (source: Producer Price Indexes).

Long Distance and Bell Operating Company Equity Income - are the real dollar returns, including capital gains and dividend payments, to holding, in proportion to their equity value, stock in AT&T and MCI and stock in the seven Bell operating companies (source: Center for Research on Security Prices).

Special and Switched Access Excess Return - are the real values of actual returns in excess of the allowed return for Southwestern Bell special and switched access service (source: Southwestern Bell).

Table 1
Demand Determined by
Nominal Price and Switched Access Share
2SLS Estimates

Variable	AT&T Quantity Ratio	OCCs Quantity Ratio	Variable	AT&T Price Ratio	OCCs Price Ratio
Intercept	-2.13	-5.80	Intercept	0.44	-7.63
	(2.45)	(2.39)		(1.48)	(4.29)
Price Ratio	-0.22[7]	-0.20	Quantity Ratio	-0.12[2]	-1.09[1]
	(0.12)	(0.18)		(0.05)	(0.30)
Switched Access	1.16[1]	0.22	Subscriber Line	0.23	1.58
Share	(0.30)	(0.94)	Charge	(0.35)	(1.19)
Income per capita	1.21[2]	1.98[4]	Telecommunications	0.19	-3.49
	(0.50)	(0.95)	Worker Wage	(1.32)	(4.56)
Corporate Bond	0.09		SWBT Corp. Bond	8.10[3]	22.05[8]
Yield to Maturity	(1.22)		Yield to Maturity	(3.71)	(12.63)
Residential Lines	-1.08[8]	1.67	Price of Transmission	1.38	13.16[1]
	(0.61)	(1.20)	Equipment	(0.89)	(3.70)
Non-Residential	1.07[1]	-3.97[1]	Price of Switching	-1.56[7]	1.63
Lines	(0.32)	(0.94)	Equipment	(0.86)	(2.26)
Mining	0.11[3]	0.49[1]	Special Access	-1.58[1]	-6.25[1]
Employment	(0.05)	(0.10)	Excess Returns	(0.33)	(1.67)
Construction	0.36[1]	-0.08	Switched Access	0.19	1.15[5]
Employment	(0.12)	(0.22)	Excess Returns	(0.14)	(0.59)
Manufacturing	0.17	0.27	Long Dist. Company	-1.03	1.53
Employment	(0.15)	(0.41)	Equity Income	(3.01)	(11.27)
Transportation & Publ.	0.88[4]	2.08[2]	Bell Oper. Company	1.51	2.27
Util. Employment	(0.43)	(0.85)	Equity Income	(1.87)	(6.57)
Retail & Wholesale	-1.63[1]	-1.19			
Trade Employment	(0.40)	(0.78)			
Finance, Insurance, &	-0.71[1]	1.94[1]			
& Real Estate Empl.	(0.24)	(0.57)			
Services	0.41	-1.55[1]			
Employment	(0.28)	(0.56)			
Government	0.16	0.10			
Employment	(0.11)	(0.20)			
Rho	0.11	0.53		0.59	0.79
Number of Obs.	175	175	Number of Obs.	175	175
Adjusted R^2	.92	.92	Adjusted R^2	.35	.09

Standard errors are in parentheses and superscripts denote significance levels for a two-tailed test if less than 10%. Observations are weighted by state population.

Table 2
Nonnested J Test Results
Nominal versus Shadow Price Models

Estimate of Alpha	Nominal Price Model	Shadow Price Model
AT&T	1.40[1]	-0.88
	(0.40)	(0.69)
OCCs	1.53	-0.56
	(4.30)	(4.48)

This table presents coefficients and standard errors of α in the equation

$$y = x_1\beta_1 + \alpha x_2\hat{\beta}_2 + \epsilon$$

where subscripts denote the competing models describing the data generating process. Superscripts reported in the table denote significance levels for a two-tailed test of α greater than zero if less than 10 percent.

Table 3
Elasticities of Substitution
in Competing Models

Elasticity of Substitution	Nominal Price Model	Shadow Price Model
AT&T	-0.28[3]	-0.34[1]
	(0.13)	(0.09)
OCCs	-0.19	-0.21
	(0.17)	(0.18)

Standard errors are in parentheses and superscripts denote significance levels for a two-tailed test if less than 10%. Observations are weighted by state population.

Costly Gains to Breaking Up:

LECs and The Baby Bells

John S. Ying and Richard T. Shin*

Review of Economics and Statistics, forthcoming

*University of Delaware and Federal Trade Commission, respectively. This paper does not necessarily represent the views of the Federal Trade Commission or any of its members. Revisions on this paper were made while Ying was visiting the University of British Columbia. We thank Hendrik Houthakker and the referees for comments, and members of the Industry Analysis Division at the Federal Communications Commission for data assistance.

Costly Gains to Breaking Up:

LECs and The Baby Bells

John S. Ying and Richard T. Shin

Review of Economics and Statistics, forthcoming

Abstract

While the divestiture of AT&T was intended to produce benefits in the long-distance market, the evidence suggests it has created an unexpected side benefit in local telephone markets. Our results show that local exchange carriers have realized immediate cost savings in responding to competitive pressures since the breakup, with the Baby Bells experiencing generally larger gains. Dynamically, these productivity gains have increased over time at a relatively constant rate. Although gains of 3-5% of total cost are not that large, the absolutely large costs of telephone companies imply significant cost savings of nearly $72 million for the representative firm.

Costly Gains to Breaking Up:

LECs and The Baby Bells

Even before the American Telephone and Telegraph Company (AT&T) divested itself of its 22 local Bell operating companies (BOCs) on January 1, 1984, some economists such as MacAvoy and Robinson (1983) believed that it had in fact won by losing the court battle. A priori expectations were that consumers and AT&T would benefit from increasing competition. Reorganized into 7 regional holding companies (RBOCs or the Baby Bells), BOCs had received a bad or at best neutral deal. However, the early evidence suggests the opposite. As pointed out in the press and by Crandall (1988), the Baby Bells are emerging as formidable foes.

Available evidence indicates that RBOCs and other local exchange carriers (LECs) have been responding to competitive pressures arising from the breakup. Cost-cutting efforts in new unregulated markets are likely to spill over into regulated telephone operations. Furthermore, the prospect of AT&T and other carriers entering their lucrative intra-LATA toll market and threats of bypass are forcing LECs to be more competitive with respect to costs, prices, and service quality. The gradual introduction of incentive regulation by state regulators gives telephone companies material incentives to increase productivity. For these and other reasons, there is a clear sense from LEC executives that they need to be more competitive.

In this paper, we examine the extent to which the AT&T divestiture has affected the efficiency of BOCs and other large LECs. Have gains in productivity contributed to their strong performance? If so, this unexpected side benefit of the breakup may be more or as important as expected benefits in the long-distance market. To analyze this empirical question, we estimate a cost function with a pooled cross section time series sample over 1976-87. Our results show that LECs

have been improving their operational efficiency and have been able to do so immediately. Dynamically, these productivity gains have increased over time at a relatively constant rate. Although the gains as a percentage of total cost are only in the 3-5% range, the absolutely large costs of telephone companies suggest that the cost savings have been significant. For the representative firm in 1987, the simulations find productivity gains of nearly $72 million.

I. Cost Model

To analyze the impact of the breakup on productivity, we use techniques similar to those in Ying (1990), which studies the case of motor carrier deregulation. A multiproduct cost function for telephone local exchange carriers can be written as

$$C = C\ (w,\ y,\ a,\ b,\ d,\ t)$$

where C is long-run total costs, w is a vector of factor prices, y is a vector of outputs, a is a vector of operating characteristics, b is a BOC indicator variable, d is a divestiture variable, and t is a time trend.

To overcome data limitations in past studies, we estimate a cost function for LECs, on which there are more extensive and reliable data. Our cost model is modified from that in Shin (1988), which estimates a cost function for wire centers and central offices. To determine the cost structure of LECs, we employ the translog flexible functional form, which is jointly estimated with factor share equations using Zellner's seemingly unrelated regressions procedure.[1] Please refer to Shin and Ying (1992b) or Ying (1990) for a detailed description of the translog and estimation technique.

To measure the direct impact of the AT&T divestiture on LEC productivity, we calculate the percentage change in cost due to divestiture, given by

$$(C_1 - C_0)/C_0 \cdot 100 = [\exp\ (\ln\ (C_1/C_0)) - 1\ ] \cdot 100 \qquad (1)$$

$$= [\exp\ (\nu_d + \Sigma_i\ \nu_{di}\ \ln\ w_i + \Sigma_k\ \nu_{dk}\ \ln\ y_k +$$

$$\Sigma_m\ \nu_{dm}\ \ln\ a_m + \mu_{bd}\ b + \nu_{dt}\ t)\ -\ 1] \cdot 100$$

where C_1 and C_0 are total costs with the divestiture variable evaluated at d=1 and d=0, respectively, and the parameters are from d and its interaction terms.

Besides this direct effect, the divestiture can have so-called indirect effects on the outputs, inputs, and operating characteristics which in turn, would affect productivity and cost. Although they are important and potentially very interesting, Ying (1990) and an earlier version of Ying and Keeler (1991) find them to be small relative to the direct effect. Given our direct effect results, we leave the indirect effects for future research.

II. Data and Variables

The data set consists of a panel of local exchange carriers over 1976-87. The primary data source is the Statistics of Communications Common Carriers, published by the Federal Communications Commission (FCC). Because of omissions and changing reporting requirements, some data have been collected from detailed forms at the FCC. We consider only those firms with continuously available data. The sample comprises 46 large LECs, of which 22 are BOCs, and 546 observations.

To calculate total cost, all expenses excluding capital costs are given by operating expenses minus depreciation. For capital expenses, a real capital stock has been obtained by dividing gross communication plant by the 20-year average communications equipment implicit price deflator, available from The National Income and Product Accounts. The annuity form of depreciation is used to obtain annual interest and depreciation costs. The interest rate is taken from the average price of new capital on domestic telephone bonds, listed in Moody's Public Utility Manual. Working capital is accounted for by current assets minus liabilities.

The price of labor (PL) is compensation per employee. Number of employees data for 1982-87 are taken from the pensions paid schedule (60B) of the Annual Report, Form M or more detailed Annual Employment Reports, Form 395. Beginning in 1985, compensation data are available as a footnote in the operating expenses schedule (35) of Form M. Where reasonable, some labor prices have been generated by averaging. The price of capital (PK) is capital expenses divided by the average number of telephones or access lines. For the price of other factors (PO), residual expenses are divided by the average number of telephones. The factor shares are the corresponding expenses over total cost.

Output is represented by the average number of access lines or telephones (TL), with output usage variables consisting of local calls (LO) and toll calls (TO). Due to changes in reporting practices after divestiture, the ratio of local to toll calls has been regressed on time to generate compatible toll call figures for some firms. For some missing observations, averages or ratios from other years are used.

To capture output attributes, the vector of operating characteristics includes the number of central offices (CO), the percentage of electronic access lines (EA), and average loop length (AL) or miles of cable per telephone, which indicates the density of service. EA serves as a proxy for technology or quality. In the translog, zero values for EA have been changed to 0.00001. In a few cases, existing EA data have been averaged or regressed on polynomial terms of time, and an apparent change in classifications of electronic lines has led to some adjustments.

Because the Bell operating companies were originally part of AT&T, they may be considered different from the other LECs in the sample. While many of these differences may be exhibited by existing variables, a variable indicating whether the company is a BOC would capture other less tangible features. This variable

(B) is a dummy variable equal to 1 if the LEC is a BOC and 0 otherwise.

The divestiture variable (D) is also a dummy variable, with value 0 from 1976-83, and 1 from 1984-87. Our use of a translog function captures lagged or diffused effects over time through the interaction term between D and the time trend. More generally, any measured productivity gains should be viewed as arising from not only the divestiture itself, but also from increased competition and state deregulation following the breakup. To prevent a downward bias in D, a time trend (T) has been added to account for possibly unmeasured dynamic changes, such as technological progress.

We believe that we have constructed one of the most comprehensive telecommunications data set to date. But even the best available data may have shortcomings. For example, prior to 1984, most telephone companies only report the number of telephones rather than access lines. Since telephones include extension phones, they may overestimate the number of access lines. Thus, the estimated productivity gains from divestiture are smaller than the true gains or our estimates are biased upward. Nevertheless, even with minor shortcomings, our data are the best available for examining the costs of telephone companies.

III. Estimation Results

In Table 1, we provide the translog results for the first-order parameter estimates and all terms involving the divestiture variable. Complete results are available upon request. Of the 76 estimated parameters, 36 are significant at the 1% level, 8 are significant at the 5% level, and 5 are significant at the 10% level. Parametric tests using the quasi-likelihood ratio show that each of the independent variables is highly significant, well beyond the 0.05%. They suggest that although some of the individual parameters are not significant, none of the variables should be deleted from the model.[2]

Next, we evaluate the plausibility of the parameter estimates, postponing an analysis of the divestiture variable to the next section. The first-order output parameters are all positive, less than 1, and significant at the 0.02% level. At the sample mean, summing the output cost elasticities yields an overall scale elasticity of 0.9621, implying slight economies of scale. It suggests that the large LECs in our sample may not have exhausted sources of scale economies given the market demand. However, it does not necessarily imply that they are natural monopolies.[3] Evaluating the scale elasticities with D=0 and 1 indicates that the breakup has had no appreciable effect.

The cost elasticities with respect to the factor prices or the factor shares, at the sample means, are all positive and of plausible magnitudes. The factor share for labor is 0.3170, for capital is 0.5196, and for other inputs is 0.1634. Overall, these estimates indicate that technological improvements have led to substitution of capital and other inputs for labor, and that the divestiture has somewhat accelerated this process.

Cost savings due to technological changes can be measured by the percentage electronic access variable. Its small first-order as well as square term are negative and highly significant, indicating that as a higher percentage of access lines are converted to electronic switches, cost savings will grow slightly. The results are plausible since electronic access can reduce costs in many ways.

Average loop length (AL) has significant positive first-order and square terms, indicating that costs rise rapidly as AL increases. If demand is not densely packed so that more miles of cables are needed per telephone, then costs should rise accordingly. Central offices (COs) seem to only have an indirect effect on costs, since their significance is derived from the interaction terms. For instance, more COs will result in a decrease in the cost elasticity for AL.

The significance of the Bell indicator variable and the positive first-

order parameter suggest that their costs are not only different but higher. This difference has decreased with time. From the other interaction terms, BOCs tend to use less capital and labor as compared to non-Bell firms. Increasing local calls, COs, and average loop length are all more costly for the BOCs.

With a time trend variable, we can measure normal productivity changes which would have occurred in the absence of divestiture. The first-order coefficient is negative and highly significant. It suggests that failure to include T in our model may have resulted in a biased estimate of the effect of the divestiture. The positive square time term is significant, indicating that normal productivity growth occurs at a decreasing rate over time.

Finally, we briefly present regularity conditions for the estimated translog equation. Homogeneity is imposed and continuity is automatically satisfied. Our calculations show that only 7 of 546 observations violate monotonicity, while 90.0% of the data points are concave in w, and regular. These results are reassuring considering past problems with regularity.

IV. The Effect of the Divestiture on LEC Productivity

We now turn to the focus of this paper, the effect of the AT&T divestiture and subsequent competition on the productivity of local exchange carriers. The first-order parameter estimate of the divestiture variable (D) is -0.0539, which suggests that costs have decreased. It is significant at the 5% level. Also accounting for the second-order terms, the quasi-likelihood ratio test indicates that D is in fact quite significant, well beyond the 0.05% level.

In applying equation (1) to calculate the effect of the breakup on productivity, the variables are held at yearly mean values, so that they can be interpreted as those of the representative firm in any given year. By simulating the results over 1984-87, we can observe differential dynamic effects. Cost

simulations for the translog are presented in Table 2. Components of equation (1) before taking the exponential are included to indicate the primary sources of the change. Since BOCs differ from non-Bell LECs, the percentage change in costs has been calculated for each of their representative firms. Finally, these computations were performed on individual observations in the sample. The averages for non-Bell LECs, BOCs, and the sample in each year and the standard errors are also given in this table.

The results indicate that LECs and the Baby Bells have been quick to realize productivity gains. Within the first year of the breakup, the representative firm has reduced costs by over 2.5% more than otherwise. It suggests that the local telephone companies have not had to make any drastic initial changes in their operations, which would have probably increased costs in the short run. In the following years, these advances in productivity continue to grow by approximately 0.5% per year. In 1987, costs are over 4% lower.[4] Over time, LECs are better able to rein in costs, as they reduce their reliance on less-skilled labor, modernize their plants, and develop other cost-cutting techniques.

On a percentage basis, these cost savings could hardly be described as large. However, given the capital-intensive nature of telephone technology and the resultant absolutely high costs, the savings amount to substantial figures. For example, in 1987, the representative firm in our sample has a total cost of over $1.6 billion. A cost savings of even 4.138% implies a productivity gain of about $72 million. If aggregated across the large LECs in just our sample, it represents savings of nearly $3 billion.

The cost savings for the representative Bell and non-Bell firms show a similar pattern. Of particular interest is that BOCs have achieved larger productivity gains in each year. This is to be expected since the breakup did

affect them most directly. Given that they faced more changes, they probably have more areas for cost-cutting. Nevertheless, non-Bell carriers have reacted to the divestiture too. Their productivity gains are more likely the result of the host of changes that followed the breakup, rather than the breakup itself.

Simulations for each of the firms, averaged by year and categories, produce similar though generally higher savings. They indicate that analysis of the representative firms does convey the typical effect of divestiture on firms in our sample. If these slightly larger gains are expressed in dollars, they imply a savings of about $77 million for the representative firm in the sample. The standard errors are about 0.25%, suggesting that the productivity changes are statistically different from zero.[5]

From the component terms in Table 2, the specific sources of these cost savings can be identified. The first-order divestiture coefficient and its interaction term with time are of the largest negative magnitude. The only other terms of the same order of magnitude are access lines and local calls, which lead to higher costs. All other components are small, and on balance, can slightly contribute to productivity gains or losses depending on the year. Individually, most are reasonably significant, especially the PL, TL, LO, and CO terms.

By differentiating the percentage change in cost with respect to the log of a variable, we can decompose the direct effect of divestiture into its various components. These calculations have been simulated for the representative firm and are presented in Table 3. Increasing all these variables by 1% and time by 1 year would tend to increase the productivity gains arising from the breakup by about 3%. Higher other input prices, more local calls, and more central offices are the more important factors which tend to reduce the cost gains. On the other hand, larger labor prices, more access lines, and longer average loop lengths all produce more cost savings. Of these variables, the effects of PL and TL are

especially large. They suggest that, holding all else constant, having higher-skilled labor and more access lines or greater market penetration would lead to lower post-divestiture costs.

V. Conclusion

U.S. regulation of telecommunications essentially is the story of AT&T. When it divested itself of the BOCs in 1984, it was a monumental turning point for U.S. regulatory policy as competitive long-distance service was severed from the perceived natural monopoly of local telephone service. Although issues such as subadditivity and economies of scope were never clearly resolved,[6] most economists considered the breakup a pro-competitive change. The benefits were primarily foreseen in the long-distance market. However, emerging evidence suggests that the local exchange carriers have also been responding to changes brought on by the divestiture. Our simulation results show that LECs have indeed realized sizable cost savings. As noncommunications businesses contribute more to revenues and LECs become full-fledged competitors in these and other new markets, these costly gains to breaking up AT&T are likely to only grow.

References

Crandall, Robert W., "Surprises from Telephone Deregulation and the AT&T Divestiture," American Economic Review, 78 (May 1988), 323-327.

Houthakker, Hendrik S., "Growth and Inflation: Analysis by Industry," Brookings Papers on Economic Activity, 1 (1979), 241-257.

MacAvoy, Paul W. and Kenneth Robinson, "Winning by Losing: The AT&T Settlement and Its Impact on Telecommunications," Yale Journal on Regulation, 1 (1983), 1-42.

Shin, Richard T., "Econometric Estimation of Telephone Costs for Local Exchange Companies: Implications for Economies of Scale and Scope and Regulatory Policy," Unpublished doctoral dissertation, Univ. of California, Berkeley, July 1988.

Shin, Richard T. and John S. Ying, "On Estimating the Box-Tidwell Flexible Functional Form," Working Paper No. 90-16, Dept. of Economics, Univ. of Delaware, Oct. 1989, revised Mar. 1992a.

Shin, Richard T. and John S. Ying, "Unnatural Monopolies in Local Telephone," RAND Journal of Economics, 23 (Summer 1992b). 171-183.

U.S. Federal Communications Commission, Statistics of Communications Common Carriers, Washington, DC: U.S. Govt. Printing Office, 1976-87.

Ying, John S., "The Inefficiency of Regulating a Competitive Industry: Productivity Gains in Trucking Following Reform," Review of Economics and Statistics, 72 (May 1990), 191-201.

Ying, John S. and Theodore E. Keeler, "Pricing in a Deregulated Environment: The Motor Carrier Experience," RAND Journal of Economics, 22 (Summer 1991), 264-273.

Endnotes

1. To test the functional specification, we estimate a hybrid translog, which transforms all independent variables except factor prices by the Box-Cox metric. Although others have estimated Box-Tidwell functions, Shin and Ying (1992a) have shown that correctly imposing homogeneity restricts the function to the extent that it is no longer a second-order approximation.

2. In the hybrid translog, the Box-Cox metric is -0.0292 with an asymptotic p-value of 0.0198, or little is gained by using a hybrid translog. Of 76 parameters, only 1 of 8 sign changes is significantly different from 0 and the vast majority are of similar magnitude.

3. For an analysis of this issue, see Shin and Ying (1992b).

4. Note that these gains from the breakup are above and beyond normal productivity growth, which some past studies using aggregate indexes have found to be about 6% (see, for instance, Houthakker (1979)).

5. Simulations for the hybrid translog are comparable to those for the translog, with slightly larger magnitudes.

6. For some recent evidence suggesting that AT&T was not a natural monopoly, see Shin and Ying (1992b).

Table 1. Translog First-Order and Divestiture Second-Order Parameter Estimates

Parameter	Estimate	Std Error	Parameter	Estimate	Std Error
PL	0.38939	0.00734	PL·D	-0.03041	0.00712
PK	0.47837	0.00630	PK·D	0.00949	0.00617
TL	0.73024	0.04025	TL·D	-0.10101	0.02777
LO	0.09602	0.02581	LO·D	0.06917	0.01799
TO	0.12473	0.01631	TO·D	0.01053	0.01083
CO	-0.00959	0.01017	CO·D	0.02266	0.00835
EA	-0.00849	0.00400	EA·D	-0.00034	0.00421
AL	0.07794	0.02768	AL·D	-0.02968	0.01709
B	0.04448	0.01275	B·D	0.01553	0.01039
T	-0.01571	0.00302	T·D	-0.00156	0.00232
D	-0.05389	0.02624			

Table 2. Translog Simulations of the Effect of Divestiture on LEC Productivity

Components in Exponential

Year	D	PL·D	PK·D	TL·D	LO·D	TO·D	CO·D	EA·D	AL·D	B·D	T·D
1984	-.0539	.0077	.0003	.0313	.0063	.0013	-.0028	-.0000	-.0099	.0074	-.0140
1985	-.0539	.0081	-.0010	.0278	.0092	.0022	-.0088	-.0001	-.0096	.0074	-.0155
1986	-.0539	.0081	-.0029	.0255	.0103	.0032	-.0088	-.0002	-.0096	.0074	-.0171
1987	-.0539	.0043	-.0019	.0085	.0213	.0058	-.0058	-.0002	-.0101	.0085	-.0186

Percentage Change in Cost

	Representative Firm			Individual Firm Averages					
Year	non-Bell	Bell	Sample	non-Bell	SE	Bell	SE	Sample	SE
1984	-2.313	-2.467	-2.621	-2.930	0.288	-2.542	0.269	-2.744	0.200
1985	-2.727	-3.367	-3.373	-3.207	0.317	-3.630	0.257	-3.409	0.208
1986	-2.984	-3.787	-3.739	-3.539	0.341	-4.039	0.257	-3.778	0.219
1987	-3.520	-4.100	-4.138	-4.391	0.309	-4.426	0.263	-4.410	0.201

Table 3. Derivatives of the Percentage Change in Cost for the Representative Firm

Year	PL	PK	PO	TL	LO	TO	CO	EA	AL	T
1984	-2.961	0.924	2.037	-9.836	6.736	1.025	2.207	-0.033	-2.890	-0.152
1985	-2.938	0.917	2.022	-9.760	6.684	1.017	2.190	-0.032	-2.868	-0.150
1986	-2.927	0.913	2.014	-9.723	6.658	1.014	2.181	-0.032	-2.857	-0.150
1987	-2.915	0.910	2.006	-9.683	6.631	1.009	2.172	-0.032	-2.845	-0.149